THE

Tea Research Institute

OF

Ceylon

Annual Report for the Year

1958

Published by
THE TEA RESEARCH INSTITUTE OF CEYLON
ST. COOMBS, TALAWAKELLE, CEYLON.
1959.

COMMONWEALTH MYCOLOGICAL INSTITUTE
13 JAN 1960

The Tea Research Institute of Ceylon

Staff at December 31st 1958

Director	A. W. R. Joachim, O.B.E., B.Sc. (Hons.) (Lond.), Ph.D., F.R.I.C., Dip. Agric. (Cantab.).
Chemistry	
Agricultural Chemist	J. A. H. Tolhurst, B.Sc. (Hons. Agric. Chem.) (Reading)
Research Assistant,	M. Selvaratnam, B.Sc. (Hons.) (Cey.)
Research Assistant, Biochemistry	M. S. Ramaswamy, B.Sc. (Hons.) (Mysore), A.R.I.C., A.I.I.Sc.
Senior Technical Assistants	E. N. Perera, V. Mendis, T. S. Nathan
Assistant	B. P. M. Perera
Technology	
Technologist	E. L. Keegel
Research Assistant	D. Kirtisinghe, B.Sc. (Hons.) (Cey.)
Assistant	K. Sothisrihari
Plant Physiology	
Plant Physiologist	T. Visser, Dr., Ir. (L. I. Wageningen)
Vegetative Propagation Officer	F. H. Kehl
Research Assistant	K. L. D. Ameratunga, B.Sc., M.Sc. (Mysore)
Senior Technical Assistants	M. Piyasena, L. M. de W. Tillekeratne, B.Sc. (Cey.)
Assistants	A. C. B. Pethiyagoda, S. Samarasingham, N. de S. Jayasundere, D. D. Kroon, H. B. Ratnayake, J. I. H. Bandaranayake and H. R. Solomon
Plant Pathology	
Plant Pathologist	D. Mulder, Dr.
Research Assistants	N. Shanmuganathan, B.Sc. (Hons.) (Cey.), R. L. de Silva, B.Sc. (Hons.) (Cey.)
Assistants	M. K. Vythilingam, J. V. Sabanayagam, S. Murugiah and P. A. John
Entomology	
Entomologist	G. D. Austin
Entomologist, Special Research	E. Judenko, Ph.D. (Cracow)
Research Assistant	D. Calnaido, B.Sc. (Hons.) (Cey.)
Senior Technical Assistant	D. J. W. Ranaweera
Assistants	E. F. W. Fernando, C. Shanmugam and G. B. Rajapakse
Engineering	
Clerk of Works	O. J. Fernando
Works Clerk	R. A. Daniel
Storekeeper	I. P. Dissanayake
Electrician	W. R. Solomon
Mechanics	D. A. S. Opatha and K. S. Vadivelu
St. Coombs Estate	
Superintendent	T. B. Pethiyagoda
Tea Maker	A. T. Fernando
Apothecary	S. P. de Silva
Office Staff	P. E. de Silva and G. L. A. Thomas
Conductor	M. Ponnusamy
Low-Country	
Scientific Adviser	A. W. R. Joachim, O.B.E., B.Sc. (Hons.) (Lond.), Ph.D., F.R.I.C., Dip. Agric. (Cantab.)
Assistant	F. P. Jayawardene
Administration	
Administrative Secretary	G. A. D. Kehl
Personal Assistant to the Director	A. C. Perera
Assistant Secretary	C. Kirthiratne, F.C.C.S. (Lond.), F.R. Econ. S.
Accounting Assistant	A. H. B. Dias
Office Staff	F. G. de Sielvie, D. C. W. T. Amarasinghe, R. I. Pereira, W. P. Chandrasekera, F. N. Costa, E. Navaratne and V. A. Rangala

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CONTENTS

	Page
33rd Annual Report of the Board of the T.R.I.	5
Audited Statements of Accounts and Balance Sheet	13
Report on St. Coombs Estate	17
Meteorological Observations, St. Coombs	25
Report of the Director	26
Report of the Agricultural Chemist	37
Report of the Acting Biochemist	44
Report of the Technologist	51
Report of the Plant Physiologist	56
Report of the Plant Pathologist	62
Report of the Acting Nematologist	67
Report of the Entomologist	74
Report of the Entomologist, Special Research	81
Report of the Low-Country Adviser	83

THIRTY-THIRD ANNUAL REPORT OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON FOR THE YEAR 1958

Foundation.—The Tea Research Institute of Ceylon was established by Ordinance No. 12 of 1925 dated 27th October, 1925.

The Constitution of the Board of Control is laid down in the above Ordinance and in the following Tea Research (Amendment) Acts:—

No. 24 of 1948	dated	20th December, 1948
No. 32 of 1951	,,	1st September, 1951
No. 51 of 1953	,,	19th December, 1953
No. 20 of 1955	,,	14th April, 1955
No. 8 of 1957	,,	18th March, 1957

Action was taken to have the Ordinance amended in order (*a*) to appoint the Director of the Institute as an *ex-officio* member of the Board, and (*b*) to empower the Board to fix rates of salary, remuneration, bonus, royalties, allowances and all other moneys paid to its servants from time to time, and to apportion moneys derived from patents, *brevets d' inventions* and other similar rights and privileges between itself and its servants in such manner as it may deem equitable.

The members of the Board on 1st January, 1958, were:—

Ex-Officio Members

The Director of Agriculture (Dr. M. F. Chandraratna, M.B.E.).

The Hon'ble Minister of Finance (represented by Mr. H. E. Peries, O.B.E., Deputy Secretary to the Treasury).

The Chairman, Planters' Association of Ceylon (Senator T. Amarasuriya, O.B.E.).

The Chairman, Agency Section, Planters' Association of Ceylon (Mr. A. D. McLeod).

The Chairman, Low-Country Products Association of Ceylon (Senator E. W. Kannangara, C.B.E.).

The Tea Controller (Mr B. Mahadeva, C.C.S.).

Representatives of the Planters' Association of Ceylon

Mr. R. C. Scott, C.B.E.

Mr. N. B. Parker

Mr. N. M. Sanders (Actg.) for Mr. W. H. W. Coultas

Representatives of the Planters' Association of Ceylon
Agency Section

Mr. R. M. Macintyre
Mr. G. K. Newton
Mr. R. D. Wedd

Representatives of the Small Holders

Mr. V. G. W. Ratnayaka, M.B.E.
Mr. A. Divitotawela

Representative of the House of Representatives

Mr. S. Jinadasa, M.P.

Chairman: Mr. F. Amarasuriya
Secretary: Mr. G. A. D. Kehl
Solicitors: Messrs. Julius & Creasy.
Auditors: Messrs. Ford, Rhodes, Thornton & Co.
Registered Office: St. Coombs, Talawakelle.

The following changes in the personnel of the Board were recorded during the year :—

Ex-Officio Members.—Mr. R. M. Macintyre, Chairman, Planters' Association of Ceylon, Agency Section, vice Mr. A. D. McLeod as from 20th February.

Mr. C. Selwyn Samaraweera, Chairman, Low-Country Products Association of Ceylon, vice Senator E. W. Kannangara, C.B.E. as from 24th March.

Mr. H. Creighton, Chairman, Planters' Association of Ceylon, vice Senator T. Amarasuriya, O.B.E., as from 28th March.

Mr. P. W. Keun, Chairman, Planters' Association of Ceylon, Agency Section, vice Mr. R. M. Macintyre as from 1st July.

Mr. S. S. H. Silva, C.C.S., acted for Dr. M. F. Chandraratna, M.B.E., Director of Agriculture, from 9th August to 12th September.

Representatives of the Agency Section of the Planters' Association of Ceylon

Mr. G. K. Newton was renominated for a further period of three years as from 24th March.

Mr. R. J. Gilmour vice Mr. R. M. Macintyre as from 24th February.

Representatives of the Planters' Association of Ceylon.—Mr. W. H. W. Coultas resumed his seat on the Board relieving Mr. N. M. Sanders as from 22nd February.

Mr. N. M. Sanders vice Mr. N. B. Parker (resigned) as from 22nd February.

Representatives of the Small Holders.—Messrs. D. E. Hettiarachchi, J.P., and Reginald Perera vice Messrs. V. G. W. Ratnayaka, M.B.E. and A. G. Divitotawela as from October 29th.

Seven meetings of the Board were held during the year, on 10th January, 7th March, 2nd April, 27th June, 29th August, 11th October and 5th December.

The Small Holdings Service ceased to operate under the Tea Research Institute as from the 1st day of January from which date it was taken over by the Tea Control Department as previously agreed to by the Board.

The Special Committee appointed by the Board to report on the future organization and expansion of the Tea Research Institute submitted its report on 12th February. Important recommendations in regard to the future set-up and administration of the Institute and its staff with particular reference to expansion were made and accepted.

Steps were, therefore, taken to put into effect some of the recommendations for increased staff and a number of officers were recruited accordingly.

A delegation of the Board comprising the Chairman, Mr. F. Amarasuriya, Mr. W. H. W. Coultas and Mr. N. M. Sanders together with two representatives of the staff, Messrs. E. L. Keegel (Technologist) and F. H. Kehl (Vegetative Propagation Officer) paid a visit to the tea growing areas of the U.S.S.R. in September. Mr. B. Mahadeva, in his capacity as Tea Controller, led the delegation.

Seven meetings of the Board were held on 10th January, 7th March, 2nd April, 27th June, 29th August, 11th October and 5th December.

Committees.—Finance Committee.—The Chairman, T.R.I. (Mr F. Amarasuriya), the Chairman, Planters' Association of Ceylon (Senator T. Amarasuriya, O.B.E.), the Chairman, Planters' Association of Ceylon, Agency Section (Mr. A. D. McLeod), the Deputy Secretary to the Treasury (Mr. H. E. Peries, O.B.E.), Mr. J. L. D. Peiris, the Acting Director, T.R.I. (Mr. J. A. H. Tolhurst), and Mr. G. A. D. Kehl (Secretary).

The following changes in the membership of the Committee took place during the year :—

Mr. R. M. Macintyre (Chairman, Planters' Association of Ceylon, Agency Section) vice Mr. A. D. McLeod as from 20th February.

Mr. R. J. Gilmour vice Mr. R. M. Macintyre from 24th February.

Dr. A. W. R. Joachim, O.B.E. (Acting Director, T.R.I.) vice Mr. J. A. H. Tolhurst as from 6th March.

Mr. H. Creighton (Chairman, Planters' Association of Ceylon) vice Senator T. Amarasuriya, O.B.E. as from 28th March.

Mr. P. W. Keun (Chairman, Planters' Association of Ceylon, Agency Section) vice Mr. R. M. Macintyre as from 1st July.

One meeting of the Committee was held on 27th June, after which date the Committee ceased to function.

Standing Committee.—The Chairman, T.R.I. (Mr. F. Amarasuriya), Mr. B. Mahadeva, Mr. R. M. Macintyre, Mr. A. D. McLeod, Senator E. W. Kannangara, Mr. J. L. D. Peiris, Mr. N. M. Sanders (Acting for Mr. W. H. W. Coultas), the Acting Director, T.R.I. (Mr. J. A. H. Tolhurst) and Mr. G. A. D. Kehl (Secretary).

The following changes in membership took place :—

Mr. W. H. W. Coultas resumed his seat as from 22nd February; Dr. A. W. R. Joachim, O.B.E. (Acting Director, T.R.I.) vice Mr. J. A. H. Tolhurst as from 6th March.

The Committee ceased to operate from 27th June on which date the Board agreed to set up a new committee, and the Administrative Committee

took over the functions of the Standing Committee as well as those of the Finance and Building Committees.

The composition of the Administrative Committee, as agreed by the Board on 27th June, was the Chairman T.R.I., the Director of the Institute, the Tea Controller and five elected members: Messrs. R. M. Macintyre, C. Selwyn Samaraweera, R. J. Gilmour, W. H. W. Coultas and Mr. J. L. D. Peiris.

Mr. R. D. Wedd acted for Mr. R. M. Macintyre during his absence on leave.

Two meetings of the Standing Committee were held on 14th February and 9th May, and four meetings of the Administrative Committee on 1st August, 29th August, 7th November and 4th December.

Experimental and Estate Committee:— Chairman, the Acting Director, T.R.I. (Mr. J. A. H. Tolhurst), Mr. F. Amarasuriya (Chairman, T. R.I.), the Visiting Agent, St. Coombs Estate (Mr. G. K. Newton), the Superintendent, St. Coombs Estate Mr. (T. B. Pethiyagoda), the Chairman, Planters' Association of Ceylon (Senator T. Amarasuriya, O.B.E.), Mr. R. C. Scott, C.B.E., Mr. D. E. Hettiarachchi, J.P., U.M., Mr. S. P. Vythilingam, Mr. R. C. P. Adams, Mr. R. L. Harvey, Mr. J. E. Davidson, Mr. A. Watt, Mr K. Morford, C.B.E., Mr. E. N. Whitfield (Acting for Mr. R. J. S. Bean), Mr. T. Kane, Mr. M. H. Villiers, the Senior Staff of the Institute, the Vegetative Propagation Officer and the Research Assistant to the Biochemist. Mr. E. L. Keegel acted as Convener/ Secretary.

The following changes took place during the year :—

Dr. A. W. R. Joachim, O.B.E., (Acting Director, T.R.I.) assumed Chairmanship of the Committee when Mr. J. A. H. Tolhurst proceeded on leave.

Messrs. C. M. G. Moberly, E. N. Whitfield and A. J. Pelly Fry took the place of Messrs. K. Morford, C.B.E., R. J. S. Bean and T. Kane, respectively.

Mr. J. M. Stewart and Mr. C. M. Wilson acted for Messrs. C. M. G. Moberly and R. C. P. Adams, respectively, during their absence on leave.

Mr. P. W. Keun (Chairman, Planters' Association of Ceylon, Agency Section) became a member of the Committee as from 1st July.

Mr. R. J. S. Bean became a member of the Committee in his capacity as Visiting Agent for the estate to be purchased for the Low-Country Sub-Station.

Four meetings of the Committee were held on 8th February, 10th May, 9th August and 25th October.

Low-Country Committee.—Mr. F. Amarasuriya (Chairman), Mr. J. L. D. Peiris, Mr. G. K. Newton, Mr. R. J. S. Bean, the Acting Director, T.R.I. (Mr. J. A. H. Tolhurst) and Dr. A. W. R. Joachim, O.B.E. (Convener).

The following changes in the personnel of the Committee were recorded :—

Mr. A. Watt acted for Mr. R. J. S. Bean during his absence on leave.

Following the reconstitution of the Committee on 27th June, Mr. H. Creighton was elected as a member representing the Board and Messrs. R. J. S. Bean and A. Watt as co-opted members.

It was decided by the Board on 27th June that the Committee would cease to function when it had accomplished its task (*a*) of advising the Board on the selection of a suitable estate in the low-country and all matters relating to the purchase thereof and (*b*) of guiding and directing the progress of the sub-station until it was fully established, particularly in respect to the building programme.

Following the decision of the Board made on 30th July, 1957, the Committee actively pursued the matter regarding the establishment of the Low-Country Sub-Station. An interest-free loan of Rs. 2 million was recommended by the Hon. the Minister of Agriculture and Food and sanctioned by Government for the purpose.

The Committee succeeded in selecting a very suitable estate in the Ratnapura District as the location for the sub-station. Proceedings towards its acquisition were started with the approval of the Board.

In consultation with the Institute's Architect preliminary plans were drawn up for buildings, water supply and electricity supply on the estate.

Six meetings of the Committee were held during the year on 3rd March, 13th June, 25th July, 26th August, 15th October and 4th December.

Appointments Committee.—Mr. F. Amarasuriya (Chairman), the Director of Agriculture (Dr. M. F. Chandraratna, M.B.E.), Mr. J. L. D. Peiris, Mr. B. Mahadeva, Dr. E. D. C. Baptiste (Director, Rubber Research Institute), the Acting Director, T.R.I. (Mr. J. A. H. Tolhurst) and Mr. G. A. D. Kehl (Secretary).

Dr. A. W. R. Joachim,, O.B.E., became a member of the Committee on his appointment as Acting Director of the Institute on 6th March.

The Committee was reconstituted by the Board on 27th June which defined its functions to be the consideration of specific appointments of the Senior and Intermediate Staff grades to the Institute's staff.

Membership of the Committee remained as above, with the Director of the Rubber Research Institute being invited when senior technical staff were to be selected.

The Committee met on 29th January, 14th February, 3rd, 13th and 29th March, 21st June, 12th and 29th August.

Building Committee.—Mr. F. Amarasuriya (Chairman), Mr. J. L. D. Peiris, Mr. G. K. Newton, Mr. W. H. W. Coultas, the Acting Director, T.R.I. (Mr. J. A. H. Tolhurst) and Mr. G. A. D. Kehl (Secretary).

Mr. B. Mahadeva was appointed a member of the Committee on 10th January, and Dr. A. W. R. Joachim, O.B.E., took Mr. J. A. H. Tolhurst's place, as Acting Director, as from 6th March.

The Committee met on 6th March and 9th May.

Following the decision to recruit additional staff the Board approved the recommendation of the Committee for the following buildings at St. Coombs :—

(*a*) Extensions to the hostel to provide four additional rooms.

(*b*) One senior staff bungalow.

(*c*) Four junior staff bungalows.

(*d*) A new cadday (shopping centre).

(*e*) Alteration of existing cadday into a junior staff bungalow.

Work on item one was commenced at the end of the year.

On the recommendation of the Committee the Board appointed Messrs. Billimoria and De Silva, Peiris and Panditaratna as the Institute's architects on 7th March.

Trustees of the Tea Research Institute of Ceylon Junior Staff Provident Fund.—The Chairman, T.R.I. (Mr. F. Amarasuriya), the acting Director, T.R.I. (Mr. J. A. H. Tolhurst), Mr. V. G. W. Ratnayaka, M.B.E.,Mr. A. D. McLeod and Mr. E. N. Perera, representing the Junior Staff.

Dr. A. W. R. Joachim, O.B.E., (Acting Director) succeeded Mr. J. A. H. Tolhurst as from 6th March.

Mr. R. J. Gilmour and Mr. D. E. Hettiarachchi filled the places vacated by Mr. A. D. McLeod and Mr. V. G. W. Ratnayaka, M.B.E., as from 7th March and 5th December, respectively.

Committee of Management, Junior Staff Medical Fund.—The Chairman, T.R.I. (Mr. F. Amarasuriya), the Acting Director, T.R.I. (Mr. J. A. H. Tolhurst) and Mr. G. D. Austin, representing the Junior Staff.

Dr. A. W. R. Joachim, O.B.E., (Acting Director) succeeded Mr. J. A. H. Tolhurst as from 6th March.

Visiting Agent.—Mr. G. K. Newton continued to act as the Visiting Agent for St. Coombs Estate. He visited the estate on 7th February, 11th May and 25/26th October.

Finance.—The total income for the year amounted to Rs. 2,749,433/- as compared with Rs. 2,402,418/- in the previous year. The increase of Rs. 347,015/- was due to increases in profit from St. Coombs Estate (Rs. 72,767/-), cess collection (Rs. 240,127/-), interest Rs. 37,173/-). Incomes from other sources recorded a decrease of Rs. 3,052/-.

Revenue expenditure in 1958 amounted to Rs. 1,642,552/-, a rise of Rs. 165,784/- over that for the previous year, due to the recruitment of additional staff, mainly of the intermediate grade, interview expenses on senior staff, the increase in grant to the Tea Control Department against the Small Holdings Advisory Service, and increases in expenditure on field and factory experimental work.

There was a decrease in capital expenditure for 1958 of approximately Rs. 410,076/- on that for 1957. Land development Rs. 59,969/-, Buildings and Lines Rs. 241,262/-, Furniture and Equipment Rs. 75,128/-, Laboratory equipment Rs. 31,445/-, Machinery and Equipment Rs. 19,027/-, Vehicles Rs. 59,115/- and V.P. Expansion Rs. 4,094/- made up the total of Rs. 490,050/- expended on this heading.

Liabilities at 31st December totalled Rs. 247,108/- of which Pay and Passages amounted to Rs. 39,464/- and sundry creditors to Rs. 207,644/-. Nett liquid assets at same date amounted to Rs. 3,772,691/-.

The total accumulated depreciation as at 31st December was Rs. 1,586,946/-.

Acknowledgments.—The Board records its thanks to the Ceylon Association in London, the Planters' Association of Ceylon, the Agency Section

of the Planters' Association of Ceylon, Low-Country Products Association of Ceylon, Agency Houses and other institutions for their continued support and co-operation in matters connected with the Institute and the tea industry in Ceylon.

The Planters' Association of Ceylon and the Tea Controller kindly placed their meeting rooms at the disposal of the Board and deserve our special thanks.

Auditors.—Messrs. Ford, Rhodes, Thornton and Company continued to act as the Institute's auditors. The audited statement of accounts and the Balance Sheet for the year ended 31st December, 1958, are attached to this report.

G. A. D. KEHL,
Secretary.

BALANCE SHEET AS AT 31st DECEMBER, 1958.

1957 Rs.		Rs.	Rs.	1957 Rs.		Rs.	Rs.	Rs.
	ACCUMULATED FUND :				**FIXED ASSETS :-**			
	Expended on Fixed Assets.				Cost			
	Balance at 31st December, 1957	5,008,776			Additions during the year ...	480,050		
	Additions less disposals ...	411,973				5,488,826		
		5,420,749			*Less* : Sales, scrap and transfers during the year at cost	78,077		
	Unexpended Fund.			5,008,776			5,420,749	
	Balance at 31st December, 1957	954,994			Depreciation at 31st December, 1957 ...	1,390,492		
	Deduct: Adjustment in respect of previous year	10,843			Depreciation written off during the year ...	211,802		
		944,151				1,602,294		
	Less: Additions to Fixed Assets less disposals during the year	411,973			*Less:* Depreciation on sales and scraps during the year	15,348	1,586,946	3,833,803
		532,178		1,390,492				
	Add: Excess of income over expenditure	895,079						
			1,427,257	3,618,284				
5,983,770			6,848,006		**INVESTMENTS AT MARKET VALUE:**			
205,729	**CREDITORS AND PROVISIONS**		207,644		Ceylon Government Securities		917,063	
				666,990	United Kingdom Government Securities		45,060	
42,409	**PROVISION FOR FURLOUGH PAY AND PASSAGE** ...		89,464					962,123
221,205	**SMALL HOLDINGS ADVISORY SERVICE**		511,380		**CURRENT ASSETS:**			
					Stocks—General	75,583	189,684	
	Note.—Capital commitment not provided in these accounts amounted to approximately Rs. 15,200/-.				Debtors and other debit balances—Research ...	61,429	71,519	
					Debtors—Staff	18,129	87,354	
					Stocks	12,076	146,880	
				2,147,839	Cash in hand and at bank	1,786,532	2,355,291	
								2,810,568
6,433,113			Rs. 7,606,494	6,433,113				Rs. 7,606,494

We have examined the above balance sheet with the books of the Tea Research Institute of Ceylon and St. Coomb's Estate and have obtained all the information and explanations we have required. In our opinion the foregoing balance sheet, with the note thereon is properly drawn so as to exhibit a true and correct view of the financial affairs of the Institute as at 31st December, 1958, according to the best of our information and the explanations given to us and as shown by the books.

(Signed) FORD, RHODES, THORNTON & Co.,

Chartered Accountants.

THE TEA RESEARCH INSTITUTE OF CEYLON.

ESTATE WORKING ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1958.

1957 Rs.			Rs.	Rs.		1957 Rs.				Rs.	Rs.
	Estate Expenditure:—						Tea Sales—Gross Proceeds:—				
149,259	General Charges			117,722						lbs.	
87,697	Upkeep			81,220		826,390	Colombo			307,005	935,016
51,041	Cultivation			61,955		8,634	Locals On estate			10,614	9,015
105,779	Harvesting			117,206		396	Biochemical Department			337	904
97,177	Manufacture			110,429		—	Gratis			2,124	—
4[illegible]				—	488,532						
11,478	Colombo Brokerage and handling charges				14,945	845,119				320,080	944,935
—	Bonus to staff				23,843						
3[illegible]	Balance to Income and Expenditure account				418,724	269	Profit on sale of Firewood				99
835,388			Rs.	945,034		835,388				Rs.	945,034

THE TEA RESEARCH INSTITUTE OF CEYLON.

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1958.

1957 Rs.		Rs.	Rs.	1957 Rs.		Rs.
140,039	Administration of the Board	164,240	348,957	Balance from Estate Working Account		418,724
244,747	Senior Scientific Staff	252,678	2,016,471	Tea Cess ...		2,256,598
—	Intermediate Scientific Staff	56,236	45,081	Interest		72,284
168,466	Junior Scientific Staff and Minor Employees	166,193	1,800	Rent of kaddays		1,800
45,360	Laboratory	42,542	708	Profit on Stone Crusher Working		—
18,501	Library and Publication	20,984	1,645	Profit on Sale of Fixed Assets		—
127,871	Field and Factory Experiment	175,714	876	Miscellaneous Receipts		177
72,894	Travelling of Staff ...	105,151				
46,828	Engineering Department	45,907				
65,306	Maintenance of Buildings	51,008				
163,437	General Services	126,121				
44,108	Miscellaneous	45,953				
300,000	Small Holdings Advisory Service	300,000				
67,689	Replanting Expenditure	28,212				
162,894	Depreciation ...	211,802				
2,572	Pembroke Bungalow Water Supply	—				
2,809	Depreciation of Investments	442				
—	Loss on Stone Crusher Working ...	1,275				
—	Loss on Sale of Fixed Assets	836				
762,757	Balance of Income over Expenditure	895,079				
2,402,418		Rs. 2,719,133	2,402,418			Rs. 2,719,133

SUMMARY OF FIXED ASSETS AND VEHICLES– 31st DECEMBER, 1958.

	ASSET ACCOUNT				DEPRECIATION ACCOUNT				
	Cost at 31-12-57	Additions 1958	Sales Transfers and Scrap 1958	Cost at 31-12-58	Accumulated at 31-12-57	For the Year	On Sales and Scrap	Accumulated at 31-12-58	Written down Value at 31-12-58
	Rs. cts.	Rs. cts.	Rs. cts.	Rs. cts.	Rs. cts.	Rs. cts.	Rs. cts.	Rs. cts.	Rs. cts.
Land including Development	1,336,557.43	59,969.23	—	1,396,526.66	79,493.50	25,501.75	—	104,995.25	1,291,531.41
Buildings and Lines	2,504,297.43	241,186.86	51,892.20	2,693,592.09	798,548.07	73,515.13	—	872,063.20	1,821,528.89
Furniture and Equipment	363,492.62	75,088.22	—	438,580.84	105,765.95	35,735.18	—	141,501.13	296,989.71
,, Board of Survey	80,639.08	75.00	—	80,714.08	8,029.11	8,063.90	—	16,093.01	64,621.07
Laboratory Equipment	173,044.60	28,878.79	—	201,923.39	77,568.51	13,090.80	—	90,657.31	111,266.08
Experimental Machinery	77,274.20	538.45	—	77,812.65	53,725.82	7,727.42	—	61,453.24	16,359.41
Estate Machinery	183,407.86	8,635.26	—	192,043.12	156,492.47	2,691.53	—	159,184.00	32,859.12
Workshop Machinery	25,027.10	8,069.67	5,905.53	27,191.24	10,002.84	1,912.15	3,543.30	8,471.49	18,849.75
,, Equipment	14,235.55	1,783.91	—	16,019.46	4,818.65	1,423.55	—	6,242.20	9,777.26
,, Furniture	3,397.55	30.00	—	3,427.55	359.75	359.75	—	719.50	2,708.05
Vehicles, Instrum.	92,209.18	45,377.85	6,810.00	130,777.03	36,417.12	21,349.77	1,702.50	56,064.39	74,712.64
,, Workshop	33,505.31	13,737.50	14,470.00	32,772.81	30,467.84	8,117.99	10,102.50	28,483.33	4,289.48
Library Shelving	2,391.78			2,391.78	239.17	239.17	—	478.34	1,913.44
Spectrophotometer	13,589.46	2,576.22	—	16,165.68	2,717.88	1,358.94	—	4,076.82	12,088.86
Leaf Hoist ...	2,055.38			2,055.38	2,055.38	—	—	2,055.38	
Lawn Mowers	767.78			767.78	555.41	76.77	—	632.08	135.70
Monkey Grubber	2,534.77			2,534.77	1,774.29	253.47	—	2,027.76	507.01
Dusters, Sprayers and Pumps	20,923.68			20,923.68	8,328.36	2,092.36	—	10,420.72	10,502.96
Leaf Elevator	10,708.55			10,708.55	3,212.55	1,070.85	—	4,283.40	6,425.15
Winget Stone Crusher	15,733.80		—	15,733.80	7,866.90	3,933.45	—	11,800.35	3,933.45
Vegetative Propagation Expansion—Capital	32,882.40	4,093.60	—	36,976.00	2,054.15	3,288.24	—	5,342.39	31,633.31
Rs.	5,008,775.71	490,050.46	78,077.73	5,420,748.44	Rs. 1,390,491.72	211,802.17	15,348.30	1,586,945.59	3,833,802.85

REPORT ON ST. COOMBS ESTATE

Acreage

		A.	R.	P.
Tea in bearing	...	265	3	00
New clearings	...	16	1	00
Green manure and grass clearings	...	27	3	12
Land fit to open in tea	...	5	3	00
Buildings and gardens	...	49	2	11
Fuel clearings	...	36	3	14
Waste Land and ravines	...	22	0	00
		423	3	37

Approximately 1 acre of clonal tea in the No. 1 clearings was brought into plucking during the year and the acreage of tea in bearing was increased to 265¾ acres.

About ¾ acre which represents the area under Guatemala grass in the new clearings too steep for planting tea, is added on to the acreage in green manure and reduced from the acreage of the new clearings.

Weather.—(Estate gauge)

		Rainfall inches	*Wet days*	*Sunshine hours*
Registered in 1958	...	80.08	229	1842
Registered in 1957	...	97.72	221	1992
(Decennial average 1948-57)	...	90.83	230	1839

The total rainfall for the year fell short of the rainfall for the previous year by 17.64″. It will be remembered, however, that 1957 was an unusually wet year, with very heavy rainfall in December. The rainfall for 1958 was only 10.75″ below the decennial average of 90.83″. However, the number of wet days in the year compared well with previous years and rainfall was well spread out throughout the year, with mild rain during the south west monsoon months. On the whole the rainfall and sunshine figures for the year were very favourable for crop production. As in 1957, no frost was experienced during the year.

Crop

	1958 *lbs.*	1957 *lbs.*
Estimate	270,000	270,000
Total crop (including off grades)	320,080	286,171
Yield per acre on 265¾ acres ...	1,204	—
Yield per acre on 264¾ acres ...	—	1,074

The crop of 320,080 lbs. harvested for the year is a record, the estimate having been exceeded by 50,080 lbs. The yield per acre for the year was 1,204 lbs. against a yield of 1,074 lbs. in 1957. The previous best yield of 298,763 lbs. was obtained in 1955, when the acreage under tea in bearing was 267¼ acres.

This additional crop was not obtained at the expense of the prices usually obtained for St. Coombs teas. Though the daily intake of crop was comparatively large in March, April and May, yet 7-8 day rounds were maintained throughout, by cash plucking after hours on week days and also by plucking on most Sundays during the heavy cropping months. Again this year as in 1957, the standard of leaf brought into the factory had necessarily to be of a very high standard indeed, due to the adverse market conditions for anything but the best teas. The prices obtained for St. Coombs teas, in spite of public auctions in Colombo being cancelled during the May strikes and teas being sold ex-estate for shipment *via* Trincomalee, compared very favourably with neighbouring estates. The additional crop harvested did not affect the quality of the manufactured tea, as the daily intake of leaf into the factory was kept at reasonable quantities to enable the maximum supervision of manufacture. The result was that the Colombo market average for St. Coombs was actually higher on the larger crop than the prices fetched in 1957.

Prices and Total Crop Sold

Year	*Total crop sold lbs.*	*Total price cents*	*Nett price cents.*
1958	317,956	2/97.19	2/93.12
1957	283,692	2/94.37	2/90.33

St. Coombs teas continued to fetch good prices and fared better than most neighbouring factories, particularly during the strike in the Colombo Warehouses, when accumulated stale teas were sold at very low prices.

The best invoices were :—

Invoice No.	*Month*	*Rs. cts.*
5	January	5.00
8	March	5.05
12	April	5.37

Cost of Production

	1958 *Cost per lb. (Cts.)*	1957 *Cost per lb. (Cts.)*
Estimate ...	1/75.33	1/68.44
Actual ...	1/52.62	1/62.04

As a result of the record crop harvested for the year, the cost of production was almost -/23 cts. below the estimated figure. The final figure of 1/52.62 could be deemed extremely satisfactory, considering the cost of additional manure applied during the year to compensate for the extra crop harvested and the application of dolomite to almost half the estate.

The high standard of maintenance adhered to on the property as a whole necessitates a comparatively high cost of production.

Profit on Estate Working

1958	...	Rs. 418,724.32
1957	...	Rs. 345,956.80

The total profit of approximately Rs. 418,724.32 on the estate working shows a profit per acre of about Rs. 1,578/-, which has been obtained both by the large crop harvested and the good prices fetched during the year.

Capital Expenditure

1958	Rs. 152,854.02	=	47.76 cts. per lb.
1957	Rs. 183,534.77	=	64.19 cts. per lb.

The main items of Capital expenditure were:—

Internal cart road	Rs.	5,269.03
Waterborne sanitation to lines ...	,,	39,183.16
Buildings	,,	54,369.24
New clearings	,,	28,212.14
Ravines to be cleared ...	,,	5,066.23
Factory and Machinery ...	,,	13,873.55
Opening up 8 acres in Guatemala grass	,,	2,245.49
Furniture	,,	4,635.18

Plucking.—7–8 day rounds were maintained throughout the year, with individual row plucking in the new fields. The standard of leaf harvested was high. The practice of fixing a datum for each field, each day, as a plucking incentive continued to be a success. However, Sunday plucking and cash plucking had to be resorted to during heavy cropping months.

Estate Roads and Paths.—Routine maintenance work was carried out and the road through No. 10 clonal area was metalled and treated with colas.

Fuel Clearings.—All gum clearings were resupplied with young plants and wherever possible drains were deepened in marshy areas and gums supplied.

Ravines and Boundaries.—All routine work in keeping boundaries clean was completed during the year. Ravines continued to be built up with masonry and reclaimed for growing Guatemala grass.

Weeding.—The cost of weeding for the year was Rs. 9.90 per acre per mensem against an estimate of Rs. 9.91. Considering the favourable weather conditions experienced during the year for excessive weed growth, the cost per acre for weeding could be considered satisfactory.

Weeding contracts continue to be popular, particularly in the older fields, where the excellent cover of tea kept weeds down to a minimum. Further requests for weeding contracts were made by the labour force, but these requests could not be met, as children had to be found work in the area reserved for estate weeding.

Pests and Diseases.—Spraying for blister blight started in mid April and was continued till the end of the year. The Saphire double nozzles bought early in 1957 lasted through the year and there is every reason to believe they will last at least another year. They have proved quite durable and efficient. There were no serious attacks of blister in any of the fields. The pruned fields, however, continued to be sprayed with single nozzles with much attention being paid during the time of recovery from pruning. On the whole the incidence of blister on the estate was slight.

Scarlet and yellow mite attacks were again noticed with the advent of periods of dry weather. A number of heavily-infested patches were selected and sprayed with the co-operation of the Entomology Division. As a general rule, areas attacked by yellow mites were sprayed with "Spersul" and rested for 3 weeks, while individual bushes attacked by scarlet mites were sprayed with non-tainting acaricides, with the result that no resting was necessary and little crop was lost.

Pruning.—The following fields were pruned during the months indicated against each field:—

No. 3	...	March-April
No. 6	...	May-June
No. 11	...	June
No. 14A	...	July
No. 14B	...	July

The type of prune adopted continued to be a cut across 3–4″ above the previous cut, the taking out of the worst knotted branches and the cleaning out of whippy branches. All pruning and tipping was done on the slope. Recovery from pruning was best in fields 14A and 14B which are comparatively young fields with good jat tea.

Supplying and Nurseries.—As it was decided that the $7\frac{1}{4}$ acres in the No. 1 clearings which were to be planted up in tea in 1958 should remain under Guatemala grass for a year longer, there was a large excess of good clonal basket plants in the nurseries. Since the soil used in the baskets had been fumigated against eelworm, it was decided to sell these plants to estate applicants for use on their multiplication plots.

Supplying of built up ravines was done in field Nos. 3 and 12, the clone used being mainly 2025 which seems to be more adaptable to the soils in these ravines. The two bird sanctuaries, totalling about $1\frac{1}{2}$ acres in field Nos. 13 and 14A, which had been under Guatemala grass for a few years was planted up in blocks with clones 2022, 2023, 2024, 2025 and 2026. The plants in these areas have made good growth during the year.

Mossing and Ferning.—All pruned fields were treated with "Limbux" to control moss and lichen. Ferning was again done by estate labour and not on contract, as in the past, to ensure a better standard of work.

Working up Poor Areas.—Thatching with Guatemala grass at the rate of 7–8 tons per acre was done on 40¼ acres in the following fields:—

No. 1	...	2 acres
No. 3	...	34¾ ,,
No. 10	...	2½ ,, (clonal area)
Supplies in Ravines	...	1 ,,
Total	...	40¼ acres

All Guatemala grass areas on the estate were manured 3 times during the year at the recently-recommended rate of 4 cwts. of Guatemala mixture per acre per application.

Manuring.—The usual practice of applying manure at 6-monthly intervals or when a field has yielded between 450 and 500 lbs. of made tea per acre since the last application of manure, whichever is the earlier, was continued throughout the year. The proportion of nitrogen applied to most fields varied between 8 and 9 lbs. nitrogen per 100 lbs. of crop harvested. During the year the Experimental and Estate Committee, on the recommendation of the Visiting Agent, decided that fields 2 to 6 should receive a more generous application of manure. Accordingly the proportion of nitrogen was stepped up to 10 lbs. of nitrogen per 100 lbs. of crop harvested.

The usual system of dibbling the manure into the soil with 3-prong drag cultivators was adopted. Pruned fields were deep forked in the alternate row at the first and second applications of manure.

As recommended by the Agricultural Chemist, the 1952 clonal area in No. 10 field was given four applications of T/488 mixture at the rate of 36 lbs. N. per application and the 1954 clonal areas received four applications of T/175 mixture at the rate of 1 oz. per plant per application.

During the year the Experimental and Estate Committee decided, on the advice of the Agricultural Chemist, that all fields on St. Coombs should receive an application of dolomite against possible magnesium deficiency. It was agreed that the programme of application be spread over a 3-year period and accordingly all fields pruned in 1957 and 1958 were given a top dressing of ground dolomitic limestone at the rate of 5 cwts. per acre.

The following are details of nitrogen and phosphate applied to individual fields, the mixture used being T.R.I. 488.

Field No.	1956 Months Manured	N.	P.	1957 Months Manured	N.	P.	1958 Months Manured	N.	P.
1	November**	36	17	May	36	17	March	T/175	
				August	T/175		May	T/175	
				October	T/175		September	T/175	
				December	T/175		December	T/175	
2	March	46	22	February	46	22	March	36	17
	September	40	19	August	36	17	July	50	23
							December	50	23
3	March	46	22	February	46	22	January	40	19
	September	40	19	August	36	17	July	40	19
							December	40	19

**2 acres of new clonal area manured.

Field No.	Months Manured	1956 N.	1956 P.	Months Manured	1957 N.	1957 P.	Months Manured	1958 N.	1958 P.
4	April	40	19	February	56	26	February	46	22
	September	53	25	August	46	22	June	50	23
							December	50	23
5	May	36	17	June	43	20	May	46	22
	November	40	19	December	36	17	September	50	23
6	May	36	17	May	46	22	March	40	19
	November	46	22	November	40	19	September	40	19
7	May	40	19	May	40	19	March	53	25
	November	36	17	October	46	22	June	46	22
							October	40	19
8	May	40	19	April	43	20	February	46	22
	October	36	17	September	46	22	June	53	25
							November	43	20
9	May	43	20	April	46	22	February	46	22
	November	40	19	September	46	22	June	56	26
							November	43	20
10	May	36	17	April	46	22	March	56	26
	November	40	19	September	46	22	June	46	22
							October	40	19
10 Clonal area 1952 planting	May	40	19	April	36	17	March	36	17
	November	56	26	September	36	17	June	40	19
				October	36	17	September	40	19
				December	36	17	December	36	17
10 Clonal area 1954 planting	November	36	17	April	36	17	March	T/175	
				August	T/175		June	T/175	
				October	T/175		September	T/175	
				December	T/175		December	T/175	
11	April	46	22	May	46	22	March	53	25
	August	53	25	October	46	22	September	43	20
	December	46	22						
12	April	46	22	May	43	20	May	53	25
	September	53	25	November	36	17	August	43	20
	December	40	19						
13	March	53	25	April	53	25	January	53	25
	October	36	17	September	46	22	May	46	22
							August	43	20
14A	July	59	28	February	46	22	March	59	28
	November	43	20	June	53	25	June	43	20
				October	40	19	November	36	17
14B	July	63	30	February	56	26	March	53	25
	November	56	26	June	56	26	June	56	26
				September	53	25	November	36	17
				December	46	22			

The following fields received dolomite :—
Nos. 3, 5, 6, 11, 14A and 14B in November @ 5 cwts. per acre.
Nos. 2 and 12 in December @ 5 cwts. per acre.

Green Manure and Shade Trees.—The routine supplying and re-supplying of Grevillea Robusta, Albizzia Sumatrana, Albizz'a Moluccana

and dadaps in all fields pruned in 1958 and 1957 was continued throughout the year when weather conditions were favourable. Dadaps are now well established in No. 3 field where the stand of shade trees has been poor in the past.

New Clearings.—The clearings continued to make visible progress during the year and most of the planted up blocks have now a fair cover of clonal tea. A few vacancies were resupplied during the south-west monsoon. Tending of plants continued throughout the year, bending over where necessary and cutting across after sufficient healthy shoots had been thrown out. Block No. 25 which was planted up with clone 777 in July 1957 has made good progress and hardly any deaths occurred. All plants in the clearings were manured every alternate month at the rate of 1 oz. per plant, the mixture used being T/175. Compost and well-rotted cattle manure were applied to poor areas. The whole of the planted area was thatched twice during the year—once in April and again in November/December against a possible drought in January/February, 1959.

Guatemala grass in the balance 10 acres now being reconditioned was lopped three times during the year, and manured soon after at the rate of 4 cwts. of fertiliser per acre per application. The whole of this area was supplied with dadaps, grevilleas and Albizzia Sumatrana, with a view to providing some shade for the young tea supplies to be planted in 1959.

Wherever necessary terracing and masonry work in ravines continued throughout the year. The soils in a few areas which showed poor growth were examined in the laboratory and these soils were found to be infested with eelworm. With the co-operation of the Plant Physiologist, some of these areas were sown with marigolds and the results are being watched.

Large nurseries of clonal plants were laid out in both No. 1 field and No. 12 field for the heavy planting programme envisaged for 1959. The clones selected included 2023 and 2026, which are in short supply at St. Coombs, to enable large-scale manufacture tests to be done on these clones and also to have available sufficient planting material of these clones to meet the demand from estates undertaking large-scale replanting.

Factory and Machinery.—Consequent on the many general improvements done to the factory in 1957, little remained to be done in 1958, except for standardising the sifting room machinery which work will be undertaken in 1959.

The factory roof was repainted with aluminium paint and the internal paint needed only occasional touching up. Jute hessian was replaced in 5 bays of tats and a new motor was installed to work the packing machine. A new store house was built for packing materials and fluorescent lights were fitted to the sifting room.

A new Tarry nipper breaker was installed in the sifting room. A new bungalow was built for the Assistant Tea maker.

Labour.—A few more children were registered to replace the old labour who had been retired on the new scales of old age gratuities. Generally the labour force co-operated with the management throughout the year and there was little unrest.

The provision of waterborne lavatories to every family and the addition of kitchens to 20 line rooms has been greatly appreciated by the labour force. With the completion of the new reservoir it has been possible to supply sufficient pipeborne water to all the lines.

The Maternity Ward has been made more attractive to expectant mothers by the provision of living quarters for the Attendant in the hospital premises.

Another cattle shed to accommodate six head of cattle has been built for those labourers owning cows and the old school was converted to living quarters to accommodate two large families.

Manufacture.—The type of manufacture remained unaltered from that of previous years. A 4-roll programme was adopted during the quality months and continuous rolling was reintroduced when larger crops were harvested and weather was not favourable for the development of flavour.

General.—The year under review has been the most successful in the history of St. Coombs. The crop harvested and the prices realised have been well above average and the profit obtained for the estate very satisfactory, in spite of unsettled and adverse market conditions in Colombo.

Perhaps the most gratifying feature during the year has been the response noticeable in the No. 1 clearings, which had in the past given cause for anxiety to those interested in replanting old and uneconomic tea with clonal material.

T. B. PETHIYAGODA,
Superintendent.

METEOROLOGICAL OBSERVATIONS

ST. COOMBS.

(Laboratory Gauges)

MONTH	TEMPERATURES °F						Mean Relative Humidity	RAINFALL		RAINY DAYS		SUNSHINE	
	Mean Maximum	Difference from average (25 years)	Mean Minimum	Difference from average (25 years)	Adopted Mean	Mean on grass		Inches	Difference from average (25 years)	Days	Difference from average (25 years)	Hours	Difference from average (25 years)
January ...	73.9	—0.2	57.7	+2.0	65.8	53.6	74	3.94	+0.34	12	+ 1	216.57	+23.87
February ...	74.7	—1.6	55.5	+0.9	65.1	54.1	72	0.89	—1.46	6	— 2	205.00	— 5.68
March ...	76.6	—1.1	55.7	+0.2	66.1	52.2	73	10.30	+5.76	15	+ 3	219.23	—13.78
April ...	76.5	—0.9	58.1	+0.3	67.3	53.6	78	7.80	+1.43	17	+ 1	179.45	—16.99
May ...	75.0	+2.6	60.5	+0.8	67.7	52.9	84	6.37	—4.91	24	+ 6	164.70	+ 0.70
June ...	70.8	+0.2	62.3	+1.9	66.5	59.2	85	13.58	+0.48	26	—	88.35	— 3.69
July ...	71.1	+0.9	60.5	+1.0	65.8	58.2	84	4.93	—6.81	20	— 6	148.68	+43.49
August ...	68.6	—2.4	60.1	+0.9	64.3	57.7	87	10.59	+1.17	28	+ 3	52.85	—61.31
September ...	72.2	—	59.4	+1.2	65.8	59.0	82	2.62	—5.75	16	— 5	147.85	+ 7.53
October ...	69.6	—3.5	59.6	+1.9	64.6	58.7	88	13.62	+3.93	24	+ 2	84.05	—65.31
November ...	72.4	—1.1	57.3	+0.2	64.8	55.3	83	7.15	—0.27	17	— 2	155.90	— 5.62
December ...	73.1	—0.4	56.1	—	64.6	54.4	74	6.34	+1.12	11	— 4	179.85	+10.62
	72.9	—0.6	58.6	+0.9	65.7	55.7	80	88.13	—4.97	216	— 3	1842.48	—86.17
	Means							Totals					

REPORT OF THE DIRECTOR

GENERAL

The position in regard to the Senior Staff of the Institute improved during the year but was not entirely satisfactory. The post of permanent Director remained unfilled though every effort was made by the Board to secure one. The writer has been performing the duties of the Director since March this year and was preceded by Mr. J. A. H. Tolhurst, Agricultural Chemist, from September, 1957.

An Entomologist to replace the present occupant of the post who is due for retirement is to be appointed early in 1959. The services of a Nematologist will be provided by the United States Operations Mission in Ceylon and an appointee is likely to assume duties by the middle of 1959. Appointments to the posts of Chief Advisory Officer and Chief Administrative Officer are expected to be made early in 1959. Four graduate Research Assistants were appointed during the year and two more are to be recruited early in 1959; the number of Junior Staff Officers was increased by five. Appendix I shows the major staff changes during the year.

In March this year the Board of the Tea Research Institute approved a scheme for the expansion of the Institute's activities involving an appreciable addition to the staff and the inauguration of an Advisory Service. A part of the scheme has already been implemented but the major section remains to be accomplished. This will necessitate an increase in the research cess from 55 to 75 cents per 100 lb. of tea exported. The planting bodies of the Island have readily agreed to the new cess but its imposition has been deferred for some time.

Efforts to secure for the Institute a Low-country Sub-station met with much initial success. A suitable estate was selected and an agreement arrived at with the vendors in regard to its purchase. Acquisition proceedings for its possession by the Institute have been initiated. A 25-acre block of land at Kottawa has been allocated by Government for a Vegetative Propagation Unit for the Galle District, but owing to encroachments the land could not have been taken over.

Consequent on the introduction by Government in the latter part of the year of a Scheme for the rehabilitation and replanting of old and uneconomic tea, a Symposium was held in Colombo on November 29th on this subject in order to afford members of the planting community an opportunity of discussing the technical as well as administrative aspects of the Scheme. The Symposium was attended by about 150 representatives of District Planters' Associations and other tea planting interests, and according to all accounts, was very successful in its objectives and much appreciated by those attending it. The full proceedings were published in the September/December, 1958 issue of the *Tea Quarterly*.

The Institute has entered into an agreement with the Ceylon Institute for Scientific and Industrial Research in regard to the conduct of co-operative investigations on the subject of "Instant" or "Soluble" tea because of the importance of this aspect of tea technology particularly in regard to the utilisation of the comparatively large output of poor quality mid-country teas. Though work had only progressed for a few months a number of samples were prepared for test by tea tasters, but these were not up to the desired standard. There is, however, good promise of a satisfactory product being obtained in a few months.

The advisory work of the Institute in respect of both tea cultivation and manufacture continues to be heavy and occupies a large part of the time of the staff. The introduction of the replanting scheme has made heavier calls than hitherto on the time of officers on advisory activities. The appointment of an Advisory Officer will, it is hoped, permit research officers to devote more time to investigational work.

The writer acknowledges with pleasure the very great assistance that has been rendered him by Dr. F. R. Tubbs, Director, East Malling Research Station, who is the Scientific Adviser to the Institute in the United Kingdom. Dr. Tubbs' unfailing assistance and advice have been of considerable value in establishing the Institute's activities on a sound footing, particularly in regard to Senior Staff matters.

An innovation which was introduced during the year was the holding of monthly meetings of the Senior Staff and heads of Sections, when matters relating to the work of the Institute were discussed and co-ordinated action determined upon. Resulting from these meetings a number of valuable proposals have emanated, one of which was the introduction of a scholarship scheme for Junior Officers in techniques relating to their particular specialities.

RESEARCH ACTIVITIES

Agricultural Chemistry Division.—As the Agricultural Chemist was acting for the Director until March and was subsequently on leave till September, and the Senior Technical Assistant was on medical leave from June, the research activities of this Division had necessarily been restricted. An important line of investigation was that of copper accumulation in soils in view of the prospect of continued annual applications of considerable amounts of copper compounds to tea for the control of blister blight. Present indications are that most of the copper applied has remained in the top few inches of soil. Since high elevation soils have high organic matter contents and are thereby more retentive of copper, and as these often occur in the worst blister areas, the possibility of toxicity levels being reached in these soils in particular, over a long period of time, needs to be investigated. There has been no evidence, however, to suggest that the tea bush has been affected so far.

A major change of policy in respect of manurial experiments was effected during the year. These experiments which were for a number of years under the control of the Plant Physiologist have now reverted to the Chemist, who has been largely occupied since the takeover with the calculation and tabulation of the mass of experimental data collected over the years. Arrangements were taken in hand at the end of the year with our Scientific Adviser in the U.K. for the services of the Head of the Statistical Section of the East Malling Horticultural Research Station, U.K., being made available to

undertake at the Institute the statistical examination of this data, and to advise on the future of these experiments.

The manurial experiments at Endane and Sapumalkande estates have proceeded smoothly. The reasons for the markedly different yields obtained at these centres with the same maximum level of nitrogen, are to be investigated.

Continued emphasis has been given to the liberal manuring of Guatemala grass for the purposes of thatching and increasing soil fertility. An experiment initiated to test the economic limits of manure applications to the grass appear to indicate that applications up to 12 cwt. per acre per annum will prove economical.

Biochemistry Section.—With the new policy of including the Biochemistry Section with the Division of Technology a re-examination of the programme of the biochemical work of the Institute was undertaken.

Work on the rôle of pectic substances on the quality of tea has been investigated in some detail. The qualities of the different clones propagated at St. Coombs have shown an apparent relationship to the hydrolysable volatile matter of the leaf. These latter constituents appear to increase during the dry season when the quality of the manufactured tea improves. In connection with the process for manufacturing soluble tea, experiments have shown that the water soluble content of tea leaf increases slightly during withering, but decreases as the period or temperature of fermentation increases.

Technology Division.—An investigation undertaken to study the effect of age from pruning on the quality of tea was made on material from the Institute's clonal plots. Results indicate that there is little to choose between the liquoring characteristics of teas one year, two years and three years from pruning although the oldest leaf shows more pronounced flavour when this character is present. Another trial to test the effect of different levels of inorganic manures on quality has indicated that nitrogen at the 40 lb. level gives teas which are preferred to those at the 80 lb. level. There are indications that if quality is not to suffer by high nitrogenous manuring, the manure mixture should contain potash and phosphate in adequate amounts.

An important development in the year was the "Keegel" cone. This is designed to solve most rolling problems and has so far given satisfactory results.

Entomology Division.—Attention was directed chiefly to the study of problems dealing with the control of mites and nettle grub. Apart from the application of a wettable sulphur for the control of yellow mite and the subsequent discarding of two or three rounds of plucking to avoid taint, no effective control measure for the pest has yet been found. As regards Scarlet mite recent small scale experiments have indicated that Akar and Karathane, two non-tainting acaricides, are effective for controlling the pest.

A granulosis disease similar to that which attacks the fringed nettle grub was found to attack the cosmopolitan caterpillar (*Prodenia litura*), a pest of tea recovering from pruning. There was a record number of outbreaks of tea tortrix during the year which appeared to indicate the local inability of the imported parasite *Macrocentrus homonae* to keep its host under control. The reasons for this are to be investigated. Investigational work was also directed to the study of the white grub pest which was reported to affect young tea

very adversely on a few estates in the Nuwara Eliya District, and to the lygus bug (*Lygus viridanus* Motsch).

As regards shot-hole borer, which receives the concentrated attention of the Special Entomologist at Millawitiya estate in the low-country, work was confined to the study of the chemical control of the pest in tea in plucking by spraying the lower parts of the bush and the soil around the bushes. Of the insecticides tested for spraying the bushes, dieldrin has given the most promising results in regard to the mortality of beetles. A considerable reduction in the number of beetles occurred as a result of single sprayings with a dosage of dieldrin costing approximately Rs. 270/- and Rs. 120/- per acre respectively. Trials with applications of lesser cost have also been initiated. No practical recommendations can be made at present in regard to the use of chemicals for spraying against the pest as the effects of these on other pests and on the made tea have yet to be determined. No results have so far been obtained with the spraying of the soil. Of some interest in connexion with the study of this pest is the finding at St. Coombs that the female borer carries the spores of the ambrosia fungus (*Monacrosporium ambrosium*) in two sacs, one on either side of its head, from which they are transmitted into the galleries through the mouth.

Plant Pathology Division.—Dr. D. Mulder assumed duties as Plant Pathologist in July. Much attention was necessarily devoted to investigations on blister blight control. Experimental trials indicated that appreciable savings in spraying costs may possibly be achieved if spraying on the basis of sunshine records proves successful in practice. Field experiments confirmed that copper formulations used at the recommended rates for the control of blister blight had no adverse effect on the yield of tea. The trials with the use of stickers in conjunction with copper fungicides indicated that during a mild monsoon season, when the general level of infestation of blister blight was light, the addition of stickers did not appear to have any effect even when an application of as low as 3 oz. of copper oxychloride was used for spraying.

Renewed attention was given to the study of the virus disease Phloem necrosis. It can be concluded from an experiment in which diseased plants were transported to a lower elevation that temperature is the factor limiting its occurrence. A new leaf disease designated the 'oil-spot' disease is the cause of much concern in some up-country estates. Trials to identify the causative agent are in progress. The problem of 'up-country' or 'lower leaf' chlorosis was investigated and spraying experiments indicate that this chlorosis is due to a magnesium deficiency.

Plant Physiology Division.—This Division continued its multifarious activities during the year. The Plant Physiologist acted, in addition to his own duties, as Plant Pathologist till July. He also supervised the work of the Nematology Section during the year.

Results of a "bringing into bearing" experiment at Endane indicate the superiority of occasional thumb-nailing and layering over frequent thumb-nailing and early centering. Pre-pruning experiments show that pre-pruning decreases dieback in certain cases, but no increases in yield over normally pruned bushes were recorded.

Plucking experiments still continue to show the highly detrimental effects on bush size and frame of continuous fish leaf plucking at successive prunings. Fish leaf plucking, however, gives a marked increase in yield if it follows a full cycle of normal plucking or is preceded by at least one year of normal plucking in the same cycle.

An extensive shade experiment using artificial shade and clonal plants was initiated at different elevations in order to obtain data on the effect of light intensity and temperature on the growth of tea.

Vegetative Propagation.—Trials indicate that the optimal pH for the rooting of cuttings is below 5.0 and confirm that tea soil is not a suitable medium for either cuttings or young plants. Guatemala grass soil or a mixture of sub-soil, sand and peat in equal proportions is suitable both for propagation and for use in baskets. Over 140,000 cuttings were distributed to estates during the year. The total number of clones on trial at St. Coombs is 285 of which 167 are from outside estates. Yields of the clones 2024 and 2025 in test lines exceeded 4,000 lb. in the first year of the third cycle. Clone 1114 gave a test yield of over 5,000 lb. in the second year of the fifth cycle, but the quality of this clone is below average. A number of clones from private estates have also given yields approximating to or exceeding 3,000 lb. in the second year of the second cycle.

Good progress was recorded at our V.P. sub-stations at Passara and Neuchatel. A total of 87 clones is being tested out at the former and 120 at the latter. Clones 2023, 2025 and 2026 appear to be outstanding at Passara and clones 2023 and 2026 are making most progress at Neuchatel. At Enselwatte, in the Deniyaya District, clones 2024, 2023, 2026 and 2025 have shown best growth.

Nematology Section.—Considerable work has been carried out on various aspects of research in relation to the control of eelworms attacking tea, particularly in respect of the effect of cover crops on the pest. The most outstanding finding has been that marigolds (*Tagetes* spp.) markedly suppress eelworm infestation and also serve as a promising cover when intergrown with newly planted tea. Guatemala grass and several species of Crotalaria were also found to be fairly resistant to the meadow eelworm, whereas Tephrosia tended to maintain the eelworm population.

Laboratories.—The modernization of the laboratories, started the year previous, was carried out in respect of all sections except the Chemistry Division which will be completed in 1959. This has rendered working conditions much more agreeable than hitherto. Space has however become a limiting factor of further staff increases and some consideration was given to the question of laboratory expansion but no final decisions were made.

Complete inventories of equipment and fittings in each Division were prepared and brought up to date.

OTHER ACTIVITIES

Low-Country Activities.—With the transfer of the Low-Country Adviser to St. Coombs, activities in the low-country had necessarily to be restricted to such experimental work as was already being carried out. This left only the Ingiriya pruning trial in respect of which, in addition to yield records, certain physiological data have been obtained. The pruning experiment appears to indicate that an 18-month cycle, under the conditions obtaining, is beneficial and that, because of the low incidence of shot-hole borer in the area, a 3-year cycle is equally suitable. Advisory work since March was conducted from St. Coombs.

St. Coombs Estate.—Under the continued guidance of Mr. G. K Newton, the Visiting Agent for St. Coombs, the estate has had its most successful year on record. The crop harvested for 1958 was 320,080 lb. working out

to a yield of 1,204 lb. per acre. This yield was not, however, obtained at the expense of quality. Prices fetched at the Colombo auctions for St. Coombs teas were very satisfactory, considering the market conditions which prevailed during the year. The net sale average for St. Coombs teas approximated Rs. 2.93 per lb. which was exceeded only in 1956, a boom year for tea. The profit from the estate for the year approximated Rs. 420,000/-, the highest in its history.

The new V.P. clearings which gave so much cause for anxiety in the past are now beginning to show the benefits of the sound agricultural policy which has been followed during the past two or three years. Much valuable information has thereby been obtained on methods for the rehabilitation and replanting of tea on uneconomic and worn out areas.

In view of the large number of experiments carried out by the Scientific Divisions on St. Coombs Estate, it has been considered desirable to publish in this report a list of such experiments and a map showing their disposition on the estate (Appendix II). This will enable the location of sites for future experiments to be made without difficulty and prevent interference with those already in existence.

Library.—A survey of the library was undertaken by the Assistant Secretary with the assistance of the Library Clerk and the census taken revealed that it accommodated 962 technical books and 2,592 periodicals. A new set of rules for the working of the library was drawn up early in the year.

Publications.—The following publications were issued during the year:—

Tea Quarterly, Vol. XXIX, Parts I and II. (Parts III/IV in press).

Pamphlet No. 3. Selection and Vegetative Propagation of Tea by T. Visser and F. H. Kehl.

Bulletin No. 39. Annual Report for 1957.

A revision of Monograph No. 4 by Mr. E. L. Keegel on "Tea Manufacture in Ceylon" is in the press.

With the issue of this Annual Report all such reports will be published separately and distinct from the bulletins which will now be comprised of technical communications relating to any particular subject or subjects. These latter will be known as Bulletins (New Series). One such on the propagation of tea cuttings is ready for publication.

The cost of printing and distribution of the Institute's publications amounted to Rs. 19,066/-. Receipts from subscriptions and sundry sales amounted to Rs. 7,256/- and from advertisements Rs. 2,781/-.

ACKNOWLEDGMENTS

In conclusion I wish to express my thanks to the members of the Board of Control of the Institute and of its different Committees for the consideration they have shown me and the support given me in all matters connected with

the efficient conduct of the Institute's functions; to Company Agents and members of the tea planting community who have so readily provided us with facilities for investigational work whenever required; to all organizations who have in any way helped to further our activities and particularly to the Planters' Association of Ceylon who have made available their Committee rooms for our meetings on numerous occasions; and finally to all members of the staff of the Institute for the close co-operation they have extended to me in discharging my duties at a difficult period. Thanks to their efforts the Institute has, despite a serious shortage of staff during the year, a record of service of which it can justly be satisfied. I have no doubt that with an increased complement of staff, the Institute will render greater service to the Industry whose technical development it has been established to foster.

The reports of the Scientific Divisions are attached.

A. W. R. JOACHIM,
Director.

APPENDIX I

STAFF CHANGES

Appointments

Director

Dr. A. W. R. Joachim succeeded Mr. J. A. H. Tolhurst as Acting Director on 6th March. He was later confirmed as Director from that date.

Senior Staff

Dr. T. Visser acted for the Plant Pathologist up to 5th July when Dr. D. Mulder took charge of the Division of Plant Pathology. Dr. Visser, however, continued to be responsible for the work on Nematology.

Intermediate Staff

Mr. M. Selvaratnam, Research Assistant to the Agricultural Chemist from 15th January.

Mr. K. L. D. Ameratunga, Research Assistant to the Plant Physiologist from 1st October.

Mr. R. L. de Silva, Research Assistant to the Plant Pathologist from 1st October.

Mr. D. Kirtisinghe, Research Assistant to the Technologist from 1st October.

Junior Staff

Mr. T. S. Nathan, Technical Assistant to the Agricultural Chemist from 1st January.

Mr. N. E. L. Ponnaswamy, Technical Assistant to the Plant Pathologist from 1st January.

Mr. S. Samarasingham, Technical Assistant to the Plant Physiologist from 1st January.

Mr. N. de S. Jayasundera, Technical Assistant to the Plant Physiologist from 1st September.

Mr. B. P. M. Perera, Technical Assistant to the Biochemist from 1st September.

Mr. O. J. Fernando, Clerk of Works from 1st September.

Promotions

Mr. H. R. Solomon, Technical Assistant to the Plant Physiologist from 1st January.

Transfers

Mr. J. I. H. Bandaranayake from St. Coombs to Endane Estate, Kahawatte, on 15th July.

Mr. D. D. Kroon from Kahawatte Estate to St. Coombs on 29th September.

Resignations

Mr. N. E. L. Ponnaswamy, Technical Assistant, on 30th November.

Mr. S. M. Guneratnam, Technical Assistant, on 30th November.

Retirements

Mr. D. V. W. Perera, Maintenance Engineer, on 31st May.

Mr. F. P. Jayawardene, Technical Assistant, on 31st December.

Leave

Mr. J. A. H. Tolhurst was on six months leave from 5th March.

Mattekelle Estate
Scale: Approx. 845 ft. to one Inch.
REFERENCE
Tea (Field Boundaries)
Buildings & Gardens
Scrub & Gums
Grass & Ravines
Roads
Streams
EXPERIMENTAL PLOTS
Agr. Chemistry
Entomology
Pathology
Physiology
Technology
PLAN of ST COOMBS ESTATE
situated at Talawakelle in the District of DIMBULLA
Central Province
Containing in Extent 423-3-37
LLAN THOMAS Estate
Waltrim Estate
Mattekelle Estate
Kowlehena Estate
Kowlehena Estate
Maria Estate

APPENDIX II

FIELD TRIALS—ST. COOMBS—T.R.I. 1958

Division	Letter	No.	Extent in acres	Subject of investigation	Field No.	Remarks	Started
CHEMISTRY	C	1	0.5	Manuring, Soil treatment	8	—	1958
		2	0.3	Nitrogen cycle	8	—	1955
		3	1	Up-country chlorosis	10	Clone 2021	1957
		5	4.5	N.P.K.	3	—	1931
		6	1.5	N.P.K. Phosphate, type and frequency of manuring	13	—	1948
		7	2.0	Guatemala grass manurial experiment	—	—	1958
BIOCHEMISTRY	B	8	0.125	Minor element experiment	9	—	1958
TECHNOLOGY	T	1	2.5	Properties of made tea throughout pruning cycle	14B	—	
PHYSIOLOGY	P	1	1	Plucking	2	—	1958
		2	0.5	Side-pruning	3	—	1958
		3	0.5	Side-pruning	4	—	1958
		4	0.5	Side-pruning	7	—	1958
		5	1	Plucking	8	—	1940
		6	1.66	Plucking	9	—	1955
		7	0.33	Cultivation	9	—	1936
VEGETATIVE PROPAGATION	P	8	3.0	Clonal area	9	—	1937
ENTOMOLOGY	E	1	3.25	Mites	13	—	1956
PATHOLOGY	M	1	2.5	Spray timing	8	—	1958
		2	5.0	Stickers	12	—	1958
		3	—	Fungicides	12	—	1958
		4	0.01	Phloem necrosis demonstration	8	In eelworm nursery	1958
		5	0.01	Magnesium spraying	10	—	1958
		6	—	Unsprayed area	8	—	1951
NEMATOLOGY	N	4	1	Resistance of clones to eelworm	8	In eelworm nursery	1950
		7	—	Marigold-eelworm experiment	12	—	1958

REPORT OF THE AGRICULTURAL CHEMIST

A.—SOIL CHEMISTRY

1. Accumulation of Copper.—It had been intended two years ago to investigate the retention of copper by the soil, since the annual output of copper fungicides may in many areas be equivalent to 5 lb. of metallic copper per acre. Evidence of retention of copper in the top few inches of the soil has been forthcoming from many parts of the world where copper fungicides are in regular use, and in some instances there has been a sufficient accumulation of copper to cause toxicity to the crop. Retention of copper is likely to be greatest where the organic matter content of the soil is highest, and toxicity of this copper to the plant may be increased with increasing soil acidity.

In those areas of tea in Ceylon where protection against blister blight is most necessary the soil is often comparatively rich in organic matter, from 8 to 12%. The acidity of most of the tea soils in Ceylon appears to have been increasing steadily. Further, no cultivation could be contemplated which would periodically bury the copper-saturated surface layer, and it is in this layer that the tea bush tends to develop a great concentration of small feeding roots. Thus it will be seen that the possibility of toxicity from retention of copper should be thoroughly investigated before trouble arises, since a cure would appear to be impracticable.

Detailed sampling, both of the soil and of the tea bush, was done on two plots on St. Coombs, one of which has never been treated with any copper compound and the other of which has had copper treatment which can be accurately estimated in terms of weight of metallic copper applied per acre over a given period. Further samples, in less detail, were taken from three estates at widely varying elevations where soil conditions and rainfall also differ markedly.

Analyses are extremely tedious, and are still proceeding. It can, however, be stated without doubt that a high proportion of the copper applied as fungicide can be retained in the top two or three inches of soil. No evidence has yet been found to suggest that the tea bush has been affected by this accumulation. It would not be wise to comment further at this stage of the work, except to point out that copper applications have only been made over the past eight years and that if an appreciable accumulation of copper can already be detected in the soil we need to think rather carefully about future developments under continued copper applications.

2. **Uptake of manure from the soil profile.**—Earlier reports have mentioned detailed work on the conversion of ammonia-nitrogen to nitrate-nitrogen in the soil, as affected by varying conditions of rainfall, temperature and cultivation. The original intention was to use such investigations as the basis for research into problems of very great practical importance. For example: how rapidly are the manurial nutrients taken up by the tea bush;

how rapidly do they penetrate into the lower layers of the soil and how does this penetration affect the efficiency of uptake by the bush; how are such reactions influenced by methods of cultivation, detailed climatic considerations, vigour and age of the bush from pruning. It will be seen that this greatly condensed description covers a vast field of practical husbandry, but it is not so generally realised that the analytical work required to answer such queries is equally vast.

Late in 1958 it was possible to put the original ideas into operation on two plots which had been subjected to routine soil sampling and analysis since 1955. One of these plots had been limed, and the pH of the surface soil had, after a very gradual transition, eventually reached a level approximating to 6.0. The second plot showed a pH, in the corresponding soil layer, of 4.5. Associated with this difference in pH was an increase in the high pH plot in the rate of nitrification of ammonia, applied as sulphate of ammonia in the standard mixture T. 500. This variation offered yet another opportunity of studying the reaction of the tea bush to the two main forms in which nitrogen is absorbed by plant roots, and also of following their downward passage under the influence of the sporadic heavy rainstorms which were experienced at that time.

In September the two plots were light forked in both rows, and after a period of one month, when the slight stimulation of the soil microbes had subsided, the standard mixture, T. 500, was broadcast as evenly as possible. Sampling and analysis is still in progress, but it may be of value to indicate the complexity of the work by listing the necessary steps.

1. The soil is sampled in three layers: 0—2″; 2—6″; 6—9″ depth.
2. Roots are taken from each layer for separate analysis.
3. Mature leaf in the plucking table is sampled.
4. The above samplings are repeated weekly at first, with a possibility of reducing the frequency if the analytical results justify it.
5. A single experiment, such as that now referred to, will continue for at least four months.
6. Analyses on all the material sampled involve the five major nutrients: nitrogen, potassium, phosphorus, calcium and magnesium. For the soil samples "nitrogen" is estimated as ammonia and as nitrate separately.
7. Detailed rainfall and soil temperature records are kept continuously.
8. Certain physical analyses of the soil are required, but only at the commencement of such an experiment in one particular area.

When all these data are collected, it will mean that we can draw tentative conclusions about the response of a certain type of tea to a given combination of manuring and cultivation, under certain conditions of soil and climate. Considering the many possible combinations of factors commonly found in practice it may appear doubtful if such experimentation can answer such major problems. This fear need not be entertained, provided that two conditions are fulfilled:

1. Replication in various climatic districts is possible.
2. Detailed analyses are maintained.

It is hoped that staff will soon be appointed to begin to meet the first requirement. The second requirement is being met by the present programme of work, as only by attempting to correlate what might be termed in this context "field observations" with more fundamental scientific investigation can we hope to give such restricted experiments a broader application.

One example of the value of the latter remark will suffice. In the above experiment, and in the preliminary routine analyses, it has been found that the nitrate ion was not so subject to washing down into the sub-soil, or leaching, as might have been supposed. After taking into account that the tea bush and micro-organisms would have absorbed a good part of the nitrate, we suspect that there is a chemical or physical attraction between the nitrate ion and the soil which tends to resist the action of high rainfall. This, if proved, would be of great practical importance. Conversion of ammonia to nitrate in the soil cannot be prevented, and in lower elevation soils this process may proceed at greater rates than we have observed in St. Coombs soils. If we need not fear an undue loss of nitrate, then we know that one problem, at least, does not require a diversion of research.

The above observation was made on a soil type on St. Coombs, and the absorption of the residual nitrate may be attributed to either organic matter or to the clay minerals. Before we can predict whether or not the same retention of nitrate may occur in other soil types we must attempt to disentangle these possibilities. In other words, the practical problem of the efficiency of utilisation of nitrogenous manure may have an inseparable relation with the question of anionic retention by broken bond forces on the surface of highly-weathered kaolinitic minerals.

B.—PLANT NUTRITION

In anticipation of the acquisition of staff to give this subject the attention it requires, a start has been made to obtain detailed chemical analyses of leaf from various experimental areas. Fortunately such analyses can be done by professional analysts and full use is being made of such organisations. Soil analyses, unfortunately, are less amenable to such treatment.

Several chlorotic symptoms, which have been reported earlier, remain to be investigated, and preliminary experiments have shown that the solutions may not be straightforward. Until far more fundamental knowledge is obtained on the nutrient requirements of the tea bush, and on the relation of these to soil conditions, very little progress can be expected.

C.—FIELD EXPERIMENTS

In 1949, for administrative reasons, various long term field experiments concerned with manuring and soil cultivation were transferred to the Plant Physiology Division. In October, 1958, the surviving experiments were returned to the Agricultural Chemistry Division, together with one Field Assistant. This is only a temporary measure, since the proposed Advisory Division will eventually be responsible for the conduct of such experiments, by which we mean trials conducted over several years or pruning cycles with the object of investigating the application of research to practical husbandry. Supervising such complex trials is a whole time task, and we do not contemplate more than simple maintenance of the existing experiments during the near future, with the exception of one particular manurial experiment which requires immediate modification.

1. **Low-Country Manurial Experiments.**—There are two experiments under this heading, one of which, on Sapumalkande Estate, has always been under the jurisdiction of this Division since its main object has been to study a purely chemical relation, *viz.* the effect of potassium and calcium, singly and together, on low-country soil and tea. The experimental area was pruned in 1958, and treatments are continuing unchanged in the present cycle. Detailed analyses of leaf samples are in progress. We express our thanks to the Superintendent, Mr. E. N. Whitfield, for continuing to give his co-operation.

The second experiment, on Endane Estate, although very different in size and scope nevertheless has certain useful points of comparison with the Sapumalkande experiment. Pruning was done in 1958 and the present cycle is continuing with the same treatments. Once again we express similar thanks to the Superintendent, Mr. A. Watt.

Neither experiment has so far shown any appreciable response to the different treatments, for details of which reference may be made to earlier Annual Reports. This fact in itself is of interest for its bearing on general manurial recommendations, and we propose to discuss it, even though neither experiment has been in operation very long. Each has just undergone the second pruning under the experimental manurial treatments, and it could be expected that this would have given opportunity for treatment effects to have shown, if they are going to show at all, even though differences in yields might not reach a level of statistical significance until three or more complete cycles had elapsed. There would seem to be no reason to suppose that the length of the cycle, 18 months in each experiment, is a factor of importance in accounting for the following facts:—

1. Yields (as pounds of made tea per acre per annum, based on the cycle average) in the Sapumalkande experiment approximate to 3,000 lb. with a uniform nitrogen application of 160 lb. N. per acre per annum.
2. In the Endane experiment yields are remarkably uniform, approximating to 1,600 lb. even though nitrogen levels are 80, 120, or 160 lb. N, and potassium levels are 60, 90, or 120 lb. K_2O.
3. In each experiment the bushes are of the highest vigour, needless to say, and the above yield figures represent what we have always considered to be the desirable condition of high yields being given by vigorous frames.

Admittedly both areas were generously treated before the experiments commenced; further, it can be assumed that there were certain differences in the actual planting material which would explain a reasonable difference in yields between the two experiments. Nevertheless, these considerations can hardly explain the complete lack of correlation between yields and manurial applications. It is possible that chemical analysis may throw some light on these discrepancies. Such analysis will involve very detailed work, because although we have recently accumulated a considerable mass of soil analyses based on a broad soil survey, we are still ignorant of the relation between, for example, the boron content of a particular soil and the health of a tea bush growing on that soil. An experiment involving various mixtures of the familiar N.P.K. may not be explicable simply by analysis of these three nutrients alone. As soon as sufficient assistance is available, sampling of soil and mature leaf will be possible on the Endane experiment, but this in itself will be a major operation quite apart from the analytical work.

2. **Passara Manurial Experiment.**—Although this is the second oldest field experiment on tea in Ceylon, having been started in 1934, it is doubtful if any practical recommendations can be drawn from it. Certainly, the treatments as they stand at present, and as they have been for the last four years, offer no promise of assistance to modern manuring problems. One plot in every four receives no manure at all; the remainder receive either nitrogen or potash, or both together, but at only one level. The absence of chemical analyses and of samples for analysis will make interpretation of past results exceedingly difficult. Modification of the experiment may be possible, but at present insufficient time has been available to give this full consideration.

We express our thanks to the Superintendent of Gonakelle Estate, Mr. C. R. Burnet, for his co-operation in this experiment.

3. **Modified Phosphate Experiment; St. Coombs No. 13 Field.**—The present experiment was superimposed upon one which was started in 1947, and although the original comparison between superphosphate and rock phosphate (saphos) is of no economic value, this difference in the form of phosphatic manure has to remain in the present experiment because of the probability of different chemical reactions between the soil and the two phosphates. Since the experiment was modified in 1956, yields have risen until they are now close to the average yield of the remainder of No. 13 Field. It is, of course, hoped that in the following cycle the yield from these plots, with their intensive supervision, will exceed that from the rest of the field.

In the course of the present cycle it has become apparent that two plots are yielding consistently far more than is reasonable to expect. Inspection showed the reason for this, and also revealed certain other variations in the field lay-out. In view of the large number of treatments in the experiment and the small size of individual plots, a simplification in the design would seem to be desirable, and will be considered in the near future.

4. **N.P.K. Experiment, No. 3 Field, St. Coombs.**—This experiment, the oldest and the best known of our field experiments, was started in 1931, and with very few modifications has been conducted to compare the value of various mixtures of N.P.K. There are twenty-seven different manure mixtures distributed over the fifty-four plots, which were marked out in the most uniform areas of St. Coombs No. 3 Field. Management has been conducted according to ideas in vogue in the past, and although the adoption of this policy was no doubt intended to ensure the smooth running of the trial, it now appears that more frequent revision of these methods would have been desirable. Yields have tended to fall slightly since the fourth pruning cycle until the present, the ninth, which will be concluded early in 1959. Weights of wood removed at pruning, which has been done every three years have, also declined, and inspection of the bushes shows that this has been accompanied by a decline in the vigour of the frames which do not now compare at all favourably with those in the surrounding estate tea, which was identical material at the start of the experiment.

Those treatments which have omitted either potassium or phosphate, or both, could be expected to lead to degeneration as in fact they have done. However, some of the treatments compare quite closely with our standard manure mixture, T. 500, at a rate of 80 lb. of nitrogen per acre per annum which has been adopted at least for the past twenty one years of the experiment. Under very thorough experimental supervision it might be expected that such treatments would be capable of maintaining yields in excess of the 900—950 lb. per acre per annum which in fact represents the level achieved, on the

best plots, and that frames would be excellent, bearing in mind the jat of that particular area.

Once again further detailed chemical analyses will be required, as it has already been seen from a series of leaf analyses done a few years ago that there is a strong interaction between potassium, phosphate and calcium, and in fact the importance of the latter element suggests that it would be advisable to consider the experiment as an investigation into N.P.K. and calcium, rather than a simple N.P.K. trial. The form of phosphate used throughout has been superphosphate, and not the more familiar rock phosphate. Superphosphate contains a high proportion of soluble calcium, which appears to have had a depressing effect on the uptake of potassium in some treatments. This serves to illustrate the danger of arriving at conclusions from field manurial experiments unless full chemical analysis has been done. What appears, on paper, from this experiment to have been a depressing effect due to excess phosphate, may eventually be shown to have been due to an excess of soluble calcium. Rock phosphate, which contains slowly-soluble calcium might not have shown the same effect. Mention has been made of this point to show the complexity of the chemical investigations required before changes in treatments and management are imposed. Full advice on management changes will be sought from all sources, and even though the original aims of the experiment may become obscured, we are confident that results of great value can still be obtained. It is of the utmost importance that we have these areas of soil, and of tea, which have been subjected to known manurial treatments for a long period, available for detailed investigation.

D. GENERAL

The soil thermograph on Millawitiya Estate was removed in October, and was installed on Pedro Estate, where we hope to take advantage of an offer to instal a recording rain gauge as well. A twin bulb soil thermograph was installed on Kirimetiya Estate in February. To the Superintendents of all these estates we tender our thanks for their valuable assistance.

E. GENERAL TRENDS IN MANURING POLICY

It has recently become apparent that some concern is being felt because response to increasing manurial doses is not as great, in terms of yield, as it has been in past years. Although we have consistently pointed out that this trend would be noticed, sooner or later, it may be helpful if we repeat our earlier remarks.

Several years ago manurial rates began to increase markedly, very often on tea which had not previously received much manure, as represented by a balanced nutrient mixture. Thus there was then ample capacity for yields to expand towards a limit which would be set by many factors, such as climate, jat, soil type, management. The nearer that yields approach such limits, the less efficient is the response to extra manure, until finally the cost of additional manure outweighs the return from increased crop. This stage is obviously being attained on many estates.

We have deliberately encouraged the use of the terms "maintenance ratio" and "expansion ratio," referring to rates of manuring of 8 lb. and 10 lb. of nitrogen respectively, per 100 lb. of made tea obtained, always, of course, in a balanced mixture. The aim of these terms has been to bring

home to estates the fact that they could do their own experimenting to find the most efficient manurial rate to suit their individual requirements. Indeed, this experimentation could not be done so effectively in any other way; unfortunately other manurial problems are less easily solved by such methods.

It may be emphasised again that a ratio of manuring greater than 10 lb. nitrogen may still be tried wherever yields show a capacity for an appreciable increase, and where this is desired, and that a ratio of less than 8 lb. may be found capable of maintaining a yield level once bush vigour and soil fertility levels have been built up.

Where economy in the use of manure is forced upon an estate, we would prefer to see a balanced mixture retained, but used at a low rate, for instance at a 7 or even 6 lb. ratio. Omission or reduction of either phosphate or potassium has little effect on costs, and introduces fresh problems of distribution of the reduced bulk, apart from giving rise to the danger of popularising the use of nitrogenous manures alone. It might be that in some soils reserves of nutrients other than nitrogen would suffice for several years before troubles due to deficiencies made their inevitable appearance. Undue reliance on soil reserves would be sheer exploitation, not good husbandry.

It does not seem to be possible to predict with mathematical precision the yield which might be obtained from given manurial applications, although in some quarters there is still a temptation to think along these lines. Yield response is the end result of a sequence of highly complex and interacting biological processes, involving the soil, the tea bush and, inevitably, the human factor. It would indeed be surprising if a high degree of precision could be obtained from this. Relations between yields and manurial doses in three of the controlled experiments quoted earlier in this Report provide ample evidence of the variations to be encountered and the problems to be elucidated before more precision can be introduced into our manurial recommendations.

F.—PUBLICATIONS

The following papers were published:—

Tolhurst, J. A. H.—A discussion on the relation between quality and manuring. *Tea Quarterly*, Vol. XXIX, Part I, 1958, pp. 5–8.

Tolhurst, J. A. H.—General principles of soil rehabilitation. *Tea Quarterly*, Vol. XXIX, Parts III/IV, 1958, pp. 164–165.

J. A. H. TOLHURST,
Agricultural Chemist.

REPORT OF THE ACTING BIOCHEMIST

General.—The Agricultural Chemist continued to act as Biochemist during the year, and with the amalgamation of the Technology and Biochemistry sections late in 1958 this arrangement is likely to be continued only for a short period, to allow a smooth transfer.

Mr. M. S. Ramaswamy, who presents the following report, carried responsibility for laboratory administration.

J. A. H. TOLHURST,
Acting Biochemist.

Mr. M. S. Ramaswamy reports on the following investigations:—

1. **Pectic substances.**—Investigations on the fractionation of tea pectins and their effect on fermentation of tea are in progress. Tea leaf appears to contain partly methylated pectins, or more correctly pectinic acids which are water soluble, and pectic acid in combination with metallic ions such as calcium, magnesium and iron. This fraction is insoluble in water. It is also likely to contain protopectin, the precursor of pectic substances.

Protopectin, being insoluble in water, is likely to play a very small role in the manufacture of black tea. However, during withering and fermentation, part of it may be broken down to pectinic acid. The latter, which contains a small proportion of esters, is possibly the only fraction which is de-esterfied by the enzyme, pectin-methyl esterase during fermentation. The role of this biochemical reaction is to control the oxidation of polyphenols during rolling and fermentation.

Experiments carried out to determine the break down of pectinic acid during withering showed that measurable quantities of methyl alcohol were not produced during this stage of the manufacture of tea.

In regard to the pectinic acid content of tea, experiments showed that it contains only about 4–5 per cent of methoxyl groups whatever the fraction of pectic substance extracted from the green leaf. Results of a typical example are given below:

	Methyl alcohol as mgs. in 100 gms. green leaf	Methyl alcohol as per cent pectinic acid (calculated)
Fraction soluble in water	58.5	4.35
Fraction soluble in 0.5 per cent oxalic acid ...	61.0	4.54
Fraction soluble in 0.5 per cent ammonium oxalate	62.6	4.66

The study of variations in the pectinic acid content of teas is more important than other fractions since this water soluble fraction is broken

down to pectic acid during fermentation. After much experimentation a rapid method was followed which gave fairly reliable results for pectinic acid content. This was an adaptation of Walkley & Black's method* for the determination of soil carbon in which the methyl alcohol produced by hydrolysis was oxidised.

2. **The volatile matter in tea.**—The nature of the flavouring constituents of tea has been a subject of study by many scientists in tea-producing countries, but so far no satisfactory explanation has been offered regarding these substances. Shaw† put forward the theory that the oxygenated caffeine-theotannate is responsible for most of the tea flavour, while the Japanese workers have, in this connection, fractionated a number of volatile constituents. The flavouring constituents formed during fermentation and retained in made tea are present in such minute quantities that a reasonable assessment of their chemical nature is very problematic. Since the characteristic tea flavour is developed during rolling and fermentation, it is not unlikely that the methyl alcohol produced combined with acidic constituents of tea to form esters. With a view to studying these constituents work was commenced on the volatile constituents of tea under different conditions. For this purpose, the volatile constituents of tea may be divided into two groups:

(1) Free volatile matter (F.V.) consisting of all organic materials volatile in steam, and (2) hydrolysable volatile matter (H.V.) consisting mostly of methyl alcohol formed by the hydrolysis of pectinic acids. The results obtained are summarised below:

(*a*) **Volatile matter during manufacture of tea.**—Results of preliminary experiments on the volatile matter in green leaf, withered leaf and fermented material indicate a progressive increase of these constituents in respect of both free and hydrolysable volatiles.

	Volatile matter expressed as ml. decinormal dichromate in 10 gms. dry leaf.	
	F.V.	H.V.
Green leaf ...	0.9	15.7
Withered leaf (24 Hrs.)	2.0	18.9
Withered leaf minced and fermented (4 Hrs.)	3.7	21.5

(*b*) **Volatile matter in clones** of different quality.**—The volatile matter content of dried leaf in clones of different quality is given below:—

Results expressed as ml. decinormal dichromate in 10 gms. dry leaf.

Sampled during	Above average quality			Below average quality		
	Clone No.	F.V.	H.V.	Clone No.	F.V.	H.V.
November, 1957	1294	3.7	12.1	407	4.3	9.4
February, 1958	2023	3.8	11.2	1114	3.4	8.3

Indications are that the hydrolysable volatile matter is greater in the high quality clones than in the poor quality clones. It is therefore likely that part of the quality of tea may depend upon its pectinic acid content.

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*Piper, C.S., Soil & Plant Analysis (1950.)

†SHAW, W.S., U.P.A.S.I. Bull. No. 4 (b), (1935.)

**We are indebted to the Plant Physiology Division for the supply of all the clonal material used in this investigation.

(*c*) **Seasonal variations of volatile matter in clonal leaf.**—The hydrolysable volatiles were found to be related to the difference between maximum and minimum temperature on the day previous to plucking. On the other hand the free volatiles remained almost constant.

Seasonal variations of volatile matter in clonal leaf

Clonal quality	H.V.	F.V.	Difference between maximum and minimum temperature on the day previous to sampling.
Above average	10.8	2.8	16°F
	2.9	3.6	8°F
Average	12.1	3.0	14°F
	3.8	3.6	8°F
Below average	10.2	2.7	16°F
	9.4	4.3	14°F

(*d*) **Variations of volatile matter in leaf from bushes of different age from pruning.**—The results of a single analysis of clone No. T. 1114 of different ages from pruning (9, 21 and 33 months from pruning) showed a fall in the hydrolysable volatiles in bushes longest from pruning.

(*e*) **Variations of volatile matter in flush fractions.**—The results are given in the following table along with the total pectin content:—

Volatile matter in dried flush fractions (Clone No. 4)

	Free volatile matter (ml. decinormal dichromate in 10 gms.)	Hydrolysable volatile matter	Total Pectin* (Per cent dry matter)
Bud	1.0	12.9	4.9
1st leaf	1.3	16.6	6.1
2nd leaf	1.3	17.0	4.7
3rd leaf	2.0	18.2	5.0
Stalk	1.8	16.9	7.6

The results appear to show that leaves contain higher pectinic acid fraction of the total pectin than the stalk.

(*f*) **Variations of volatile matter in green leaf and made tea obtained from different elevations**—Since seasonal changes at different elevations may be presumed to affect leaf constituents in general, it was decided to proceed with the investigation of volatile matter in green leaf and made tea samples obtained every month. The work is still in progress. We are indebted to the Superintendents of a number of estates for the regular supply of the material.

3. **Effect of addition of pectic substances to the green leaf on the quality of teas.**—Green leaf from clone No. 4 was treated with the different fractions of pectic substances, withered, minced, fermented for 3 hours, and dried in the miniature drier between 130 to 180°F. The liquoring properties of the treated teas showed abnormal and undesirable characteristics when compared with the control. This may be due to the high percentage of pectin fractions used (4 to 16 per cent). Further work will be carried out in due course.

*T.R.I. Bull. No. 30 (1948).

4. **Effect of addition of methyl alcohol on fermentation of tea.**—Earlier work has shown that the tea pectin—pectinmethyl esterase system slows down the oxidation of polyphenols. The course of reaction in this system can probably be retarded by increasing the concentration of one of the products of hydrolysis, namely, methyl alcohol. An experiment was therefore conducted to find out the effect of added methyl alcohol on the liquoring quality of tea. The treated sample gave a duller infusion and showed a higher degree of fermentation than the control. The results therefore indicated that the addition of methyl alcohol promoted greater oxidation of tea polyphenols.

5. **Chemical changes occurring during the fermentation of tea.**—Laboratory scale fermentation experiments were conducted in (*a*) a vacuum (*b*) an atmosphere of carbon dioxide (*c*) oxygen and (*d*) under normal conditions. While fermentation was completely arrested in vacuum, it was found to be almost normal in a carbon dioxide atmosphere. Sufficient air (and therefore oxygen) is held up in minced or rolled leaf and possibly in the air spaces of the leaf structure for a nearly normal oxidation of tea catechins to take place. Fermentation was found to be best in an atmosphere of oxygen.

6. **Soluble Tea.**—Chemical investigations have continued on soluble tea products, some of which are now on the market. The results of these tests on two of the products are given in the following table:—

Composition of tea liquors and soluble tea.

	Liquor from black tea* after 5 mts. infusion	subsequent 10 mts. infusion	Commercial soluble tea "A"	"B"
Total water soluble solids in a cup of tea ...	0.84 g	0.26 g	1.04†g	—
Theotannin expressed as % total water soluble solids (Shaw's factor) ...	48.2	71.7	41.3	43.9
Caffeine as % total water soluble solids ...	7.7	8.8	7.6	—
Ash as % total water soluble solids ...	9.4	7.9	11.8	—

Insufficient quantities of Product B were available for all the analyses to be made. The commercial products compare favourably with normal tea.

The lower theotannin content of Product "A is probably due to the loss of water soluble polyphenols during its manufacture. Condensation of oxidised polyphenols rendering them partly insoluble in water occurs if, during the process of manufacture, the product is subjected to high temperature for long periods.

(*a*) **Water soluble constituents of green leaf grown at different elevations.**—The water soluble constituents of green leaf obtained from different elevations were determined in connection with the investigation on soluble tea. The results are given below.

*St. Coombs BOP & BOPF infused with boiling water at the rate of 200 cups per pound.
†Half tea-spoonful per cup.

Water soluble constituents in leaf obtained from different elevations

District	Elevation (ft. A.S.L.)	Monsoon	Total soluble solids (per cent dry leaf)	T.O.M.* (in lgm.)
Ratnapura High Jat	100–200	S.W.	36.9	178
Rakwana High Jat	2000	S.W.	39.5	214
Rakwana Low Jat	3000	S.W.	38.2	210
Nuwara Eliya	6200	S.W.	34.5	172
Passara	3500	N.E.	39.3	218

The differences are not conclusive.

(*b*) **Water soluble constituents in black tea during manufacture.**—It is desirable to find out the fate of water solubles during the manufacture of black tea, as this may throw some light on the desirability or otherwise of withering leaf before fermentation in the production of soluble tea. The results of analysis are given below:

Fate of water soluble constituents of black tea during manufacture

Material from the same bulk (St. Coombs factory leaf)	Water solubles
Green leaf	44.1 per cent (dry wt.)
Withered leaf	45.2 „ „
Withered leaf minced	44.3 „ „
Withered leaf minced and fired ...	39.8 „ „

There appears to be a slight increase in the water soluble constituents during withering. But if losses due to respiration during this process are taken into account (1–2%) the increase during withering becomes insignificant.

It is of interest to record some of the results obtained in 1949, but not published so far, on the changes occurring in the water soluble contents of teas manufactured under different conditions.

Water soluble constituents of leaf during manufacture

	Water solubles (on dry wt. basis)
Under Laboratory Conditions:	
Green leaf (78.2% moisture) ...	45.7 per cent
Withered leaf (60% moisture) ...	47.8 „ „
Minced and fermented for 90 mts. ...	37.5 „ „
„ „ „ „ 195 „ ...	33.2 „ „

*Total Oxidisable Matter expressed as ml. decinormal iodine solution.

Under Factory Conditions:

	Factory rolled leaf fermented under pressure*	Control (20°C)
Expt. 1.		
90 mts. @ 40°C	41.8	44.7
120 mts. @ 40°C	40.5	42.6
180 mts. @ 40°C	38.0	41.8
Expt. 2.		
60 mts. @ 40°C	41.6	43.6
180 mts. @ 40°C	35.9	41.6
60 mts. @ 27°C	43.0	44.2
180 mts. @ 27°C	40.3	41.7†

The results indicate loss of water soluble constituents as the temperature and period of fermentation increases. Fermentation under pressure also decreases the water soluble constituents.

7. **Tea Enzymes.**—(a) **Standardisation of enzyme preparations.**—Optimum conditions for the preparation of polyphenol oxidase and pectin-methyl esterase were studied.

(*b*) **Effect of minor elements on tea enzymes and chlorophyll.**—Earlier work has shown that under *in vitro* conditions traces of minor elements showed practically no effect on tea polyphenol oxidase and pectin methyl esterase activities. Work at present is in progress on the effect of a number of minor elements under *in vivo* conditions (minor elements applied to the soil) on the tea enzymes. A few preliminary experiments were carried out by dipping the flush in solutions of different minor elements in different concentrations for 24 hours.

The results are given below:

	Polyphenol oxidase activity	Pectin methyl esterase activity
Copper	No effect	Slight loss
Zinc	Slight loss	Slight loss
Boron	Increase	Slight increase
Iron	Slight loss	No effect

Of these minor elements, only copper, when present in concentration higher than 50 p.p.m. showed increase in the total chlorophyll content.

(*c*) **Effect of manuring (T500) on the N and enzyme ratio** of flush.**—The nitrogen content and the enzyme ratio were determined in the flush collected from two plots which have been used by the Agricultural Chemistry Division for studying the ammonia and nitrate cycle in the soil,

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*25 lb. pressure per square inch.

†Normal fermentation for 240 mts.

**Enzyme ratio: Polyphenol oxidase activity expressed as ascorbic acid oxidised/Pectin methyl esterase activity expressed as methyl alcohol produced. A high ratio indicates good fermentation, while a low ratio indicates poor fermentation.

and also the uptake of manurial constituents by the tea bush. One of the plots was given a single dose of lime (Limbux) in 1956 at the rate of 17 cwts. per acre. The results are given in the following table:—

Analysis of flush

	Control Plot	Lime treated Plot
Total Nitrogen % dry wt.	5.02	4.96
Polyphenol oxidase activity (mgms. ascorbic acid oxidised by 20 mgs. enzyme powder)	2.52	2.58
Pectin-methyl esterase activity (mgms. methylalcohol liberated by 20 mgs. enzyme powder)	0.59	0.39
Enzyme Ratio	4.3	6.6

The higher enzyme ratio in the lime treated plot shows the possibility of better fermenting flush from this plot.

8. **Seasonal variations in enzymes and chlorophyll in flush from copper and no-copper plots.**—This work, started at the end of 1958, is being continued during 1959.

9. **Publications.**—The following papers were published:—

Studies on the 'Fermentation of Ceylon Tea'.

Lamb, J., Ramaswamy, M. S. and Mendis, V.—Part IX. A preliminary investigation of the volatile constituents of tea leaf. *J. Sci. Food Agri.*, Vol. 9, 1958, p. 43.

Ramaswamy, M. S. and Lamb, J.—Part X. Pectic enzymes in tea. *J. Sci. Food Agric.*, Vol. 9, 1958, p. 46.

Lamb, J. and Ramaswamy, M. S.—Part XI. Relations between the polyphenol oxidase activity and pectin-methyl esterase activity. *J. Sci. Food Agri.*, Vol. 9, 1958, p. 51.

Ramaswamy, M. S.—The chemistry of tea manufacture. *Tea Quarterly*, Vol. XXIX, Part II, 1958, pp. 95–98.

REPORT OF THE TECHNOLOGIST

General.—The Technologist was away from the Island during September and October, first as a member of a delegation which visited Georgia, U.S.S.R. and later on a tour of the tea-growing areas in Assam and South India. Tocklai was also visited primarily with a view to studying the progress made by the experimental station on the development of factory machinery. Reports on these visits appear in the *Tea Quarterly*.

Advisory.—Seventy-four visits were made to factories, of which the Technologist visited 34. The rest were made by Mr. Guneratnam, because of whose resignation the Technological Division would not be in a position for some time to render the same service as in the past.

Arising mostly from these visits over 500 samples were examined. Advice on manufacture was also given from examination of teas from other estates, particularly regarding firing problems. In this connection the warning is given to those estates possessing infra-red moisture testers to make certain that their instruments are accurate. Many cases have come to light where such testers have through faulty operation or adjustment not given true readings, from which misleading conclusions have been drawn. It is strongly urged that where any doubt exists duplicate samples be sent to the Institute for check purposes. Since tea is very hygroscopic by nature, it is most important when sending such samples to see that they are packed tight in well-sealed tins.

Publications.—Monograph No. 4 was revised and up to the time of writing this report is still in the press.

The revision of a pamphlet "Tea in Ceylon" which was published in 1951 was also undertaken and brought up to-date.

Clonal Manufacture.—(*a*) **Studies.**—Work continued in improving the technique of manufacture on a miniature scale. Heating of rollers and different types of roller tables have been under investigation but no clear-cut conclusions have emerged.

(*b*) **Characteristics.**—A study was made of promising blister-resistant clones grown at St. Coombs and some low-country clones for their manufacturing qualities. It is proposed to publish shortly the results of these tests and all the data collected for the past few years on this subject in the *Tea Quarterly*.

(*c*) **Clones from Different Estates.**—Fifty-three clones were manufactured for 15 estates in the course of the year. With the installation of additional manufacturing units in different districts in the Island, the difficulties now being experienced in conducting quality tests would no doubt be overcome and it is hoped that estates would take advantage of the facilities to be provided. Incidentally, it might be mentioned that these units would be so constructed as to deal with $1\frac{1}{2}$ lb. of withered leaf at a time, which means that if they are to function at optimum efficiency 3 lb. of green leaf would at least be required. It would therefore be in the interests of estates wishing to have quality tests carried out by the Institute to provide for at least 100–150 bushes of each clone in their multiplication plots.

Pruning.—In the annual report for 1954 (Bulletin No. 36—page 35) a reference was made to the effect of age from pruning, the main conclusions from which were that: (*a*) once a bush has reached a certain age approximately 9 months after pruning the effect of the length of pruning cycle is marked only in case the leaf possesses intrinsic quality to a high degree, (*b*) the difference in quality is most marked in teas made during the flavoury season, and (*c*) the older leaf does not give an improved infusion.

It should be noted that in these experiments individual clones were used and tea manufactured by the mincing-machine technique.

The test was repeated during the year with material from the Institute's clonal plots comprising 29 different clones, not specially selected for quality. It could be assumed that the leaf represented normal estate leaf in composition and manufacturing properties. These clones were planted between 1937 and 1943 and were last pruned at the following times:—

(*a*) May, 1957
(*b*) ,, 1956
(*c*) ,, 1955

At the time the experiment started the age of the bushes in each case was 7 months, 19 months and 31 months approximately, from pruning. Plucking rounds were 9 days and 29 manufactures were carried out during the year, this time in the miniature scale equipment. The results were not inconsistent with those obtained from the previous experiment and indicated once again that differences in liquor were small. However, when flavour was present the teas from the oldest leaf were noticeably marked up. Summarizing the results, it could be concluded that for the particular ages tested, *viz.* 7–20 months, 19–32 months and 31–44 months:—

(1) Teas from leaf 7 months from pruning are not inferior in liquoring characteristics to those from up to 36 months old, but when flavour is present this character is more pronounced in the older leaf.

(2) From about the 3rd year from pruning quality shows an improvement.

(3) For a period 7 to 44 months there are no significant differences in colour, strength and infused leaf.

(4) The 7–20 months teas are practically identical with the 19–32 months teas. The other group 31–44 months gave slightly better quality after a period of approximately 36 months.

(5) Of the 29 experiments carried out, 31–44 months was preferred on 13 occasions, whilst on 12 occasions tasters could not detect a difference in quality between the three groups of teas.

In brief what this experiment has revealed is that no misgivings need arise about the quality characteristics of leaf less than 3 years from pruning. Undoubtedly, a slightly improved tea results from the extension of the pruning cycle, particularly when flavour is present, but the evidence does not suggest that quality progressively improves with the lengthening of a pruning cycle. Actually, in the last manufacture carried out when the leaf was 20 months, 32 months and 44 months respectively differences were so small to be of little significance, but because of more flavour in the last named, the valuations on the first two were lower. It would appear therefore that the main effect of age from pruning is upon flavour, but it is quite impossible of course from the evidence to date to say at what stage in a pruning cycle flavour is at its

optimum. A long term pruning experiment has just been commenced to investigate this matter further and to throw more light on the effect of age from pruning on the general characteristics of a tea. These tests are to be conducted on a larger scale than hitherto.

Manuring.—The three-factor (N.P.K.) experiment on St. Coombs still in progress and in its 9th cycle provided the material for these experiments. The following treatments were compared:—

(*a*) 40 N versus 80 N
(*b*) 20 K ,, 40 K
(*c*) 30 P ,, 60 P

Owing to the small size of the experimental plots it was not possible to undertake the work in the way it would have been preferred. For example, in comparing two levels of nitrogen it would have been preferable to use material only from those plots receiving levels of potash and phosphate in proportion to the amount of nitrogen applied. Since, however, leaf from such plots was insufficient to carry out the comparisons on a fairly large scale the leaf from the 40 N and 80 N plots included leaf treated with varying levels of K and P. Likewise, 20 K and 40 K were associated with varying levels of nitrogen and phosphate; similarly with 30 P and 60 P. It should be noted, however, that the only variable factor was the particular treatment under investigation. The results were as follows:—

(*a*) **Effect of nitrogen.**—(19 manufactures).—40 N received higher valuations on 13 occasions. On the whole, the effect of the heavier dose of nitrogen was a tea with slightly less colour, strength and quality. Flavour was also affected in a similar manner.

Despite the fact that these plots were pruned in June, 1956, the teas have frequently been reported on as greenish. Greenness was more marked in teas receiving the heavier application of nitrogen (80 N).

(*b*) **Effect of potash.**—(8 manufactures).—The indications were that manuring with more potash resulted in a better all-round tea, particularly with respect to colour and flavour.

Greenness in the liquors was again observed, 20 K being a little greener than 40 K.

(*c*) **Effect of phosphate.**—(8 manufactures).—A feature of the tasters' reports on these teas was that whereas colour declined as a result of more phosphate, there was a tendency for quality to improve. In consequence, there was very little difference in the average valuations obtained for 30 P and 60 P. No conclusive results were obtained as regards flavour and greenness of liquor.

One conclusion that may be tentatively drawn from these results is that if quality is not to be adversely affected by heavy nitrogenous manuring the manure mixture should contain sufficient potash and phosphate to offset the decline likely to be caused by this factor.

Rolling.—In the course of the year the 'Keegel' cone was developed, a description of which will be found in *Tea Quarterly* Vol. XXIX, Pt. 2. June, 1958. One of the objects in introducing this cone is to increase dhool outturn without unduly sacrificing appearance. It will not be found necessary

therefore to employ the excessive pressures normally needed with plain 35° cones. Care should be taken when using it to see that rollers are not overcharged, otherwise a big charge with very heavy pressure is bound to result in excessive 'throw out'. It is also necessary to stress that for the cone to function efficiently pressure should be relatively moderate.

The cone can be used in conjunction with any of the standard types of battens on the market but it would appear from further investigations that its performance can be improved by having a different type of roller battens to those in current use. Work is now in hand to develop a roller table to match the 'Keegel' cone.

Fermentation.—Seventeen experiments were carried out, the chief object being to study the effect of fermenting at temperatures of 80°F and 90°F on flavour in commercially rolled leaf. Results were consistent with those obtained from preliminary investigations in the past and generally show that the higher the temperature the less the quality and flavour, even for shorter periods.

As regards other characteristics these were not unduly affected by high temperature fermentation except in the case of colour which showed an improvement at 90°F for leaf fermented for the same period at room temperature of about 70°F.

The results indicate that if sufficient heat is generated during rolling, it would not be advantageous to continue fermenting the dhool at the high temperatures normally attained in the rollers.

The undesirability of warming fermenting rooms is indicated by these results.

Packing.—(*a*) **Chests.**—A new variety of Chinese ash plywood chests was tested. It conformed to the necessary standard for shipping purposes and was suitable for the packing of tea.

(*b*) **Card-board packs.**—A solution to the problems with regard to panel bulging and difficulties in sealing was sought. Wire banding or steel strapping was considered, but was not favoured because of the tendency of the strapping to cut the container. It has been proposed that corrugated cases be held in a temporary jig during the packing operation to prevent bulging. This may be a way out of the difficulty but no satisfactory solution appears in sight for sealing the flaps together. Adhesives could of course be used but the operation is messy and the risk of tainting the contents is always present.

Another difficulty with card-board packs is that if the liners are loose, additional measures have to be adopted to keep the latter in position during the packing operation. Plastic coated and aluminium laminated cases are now under consideration.

(*c*) **Linings.**—For some time the view was held that though plastic films such as Polythene, etc. were moisture-proof they were not gas resistant, especially if they were thin. It was the belief that foods and even tea do not keep fresh in packages made of such material, and that tea was inclined to lose its flavour. It is natural, therefore, that apart from the fact that plastic films have no second-hand value the tea-trade did not favour them for the packing of tea.

Since very little test data were available on the subject, comprehensive tests were carried out on a number of films to see whether they would give adequate protection against loss of flavour, at least equal to that provided by

aluminium foil of the standard gauge 0.025mm. The following materials were tested :

1.	Polythene	... 500	gauge
2.	Alkathene	... 200	„
3.	„	... 100	„
4.	Saran wrap	... 200	„
5.	„ „	... 100	„
6.	A plastic coated paper.		

Flavoury teas were stored in packets of various sizes under different conditions of temperature and humidity for periods up to 3 months and examined by various tasters from time to time. Although there was by no means unanimity with regard to flavour, the general condition of the teas after storage was such as to indicate that all the materials except Alkathene 100 gauge appeared to be as good as aluminium foil.

Moisture Meters.—A new type of infra-red moisture tester, called the Ase Moisture Balance underwent extensive tests and proved to be satisfactory for determining the moisture content of made tea. Particulars of the machine will be found in the *Tea Quarterly*.

Publications.—The following papers were published:—

Review. The Culture and Marketing of Tea by C. R. Harler, *Tea Quarterly*. Vol, XXIX, Part I, 1958, pp. 64-65.
The improvement of quality *Tea Quarterly*, Vol. XXIX, Part II, pp. 87-94.
Roller cones, *Tea Quarterly* Vol. XXIX, Part II, pp. 101-103.
Selection and quality, *Tea Quarterly*, Vol. XXIX, Parts III/IV, pp.178-179

Acknowledgments.—We have continued to receive all the help asked from Tea Tasters in Colombo and our grateful thanks are due to them for their continued interest and assistance in the tasting of experimental samples.

E. L. KEEGEL,
Technologist.

REPORT OF THE PLANT PHYSIOLOGIST

1. General.—The Plant Physiologist was, in addition to his own duties, in charge of the Nematology Division throughout the year and of the Pathology Division until July.

He attended the XVth International Horticultural Congress, held at Nice, France, in May-June, and read a paper on "Some aspects of the Propagation of Tea Cuttings." The V.P. Officer was away on a tour of tea districts in Georgia, U.S.S.R. and N.E. and S. India during September and October.

Advisory.—1,335 letters were received and 1,400 despatched.

Forty-five estate visits were made during the year and 3 Planters' Association meetings attended.

2. Vegetative Propagation.—Over 140,000 cuttings were supplied to estates during the year. In future, cuttings of approved clones can be purchased from the Superintendent, St. Coombs, at approximately -/02 cts. per internode, excluding packing and freight.

Many visits were made to advise on V.P. nurseries. The main trouble with many of these was that the sites had been used as nurseries for many years resulting in loss of soil structure. Recent experiments have proved that cuttings grow significantly better in virgin soils, *e.g.* Guatemala grass soil, patna soil, etc. Accordingly, improvement of soil conditions can be effected either by growing Guatemala grass or Mana grass for a period of two to three years, depending on the nature of the soil, or by introducing suitable soil to the site.

The investigations of the past year were restricted to determining the optimal soil acidity for propagation and the influence of different soil media on the growth of rooted cuttings.

Soil acidity.—I. In the first trial a range of pH values was obtained by the admixture of different quantities of sulphur and lime to the soil 6 months prior to planting. In order to obtain a greater pH variation half the soils were mixed with peat litter (this lowers the pH). It appeared 12 weeks after planting that 78, 32, 19, 15 and 0% of the cuttings had rooted at a pH of 4.7, 5.3, 5.6, 5.8 and 6.3 respectively.

II. The second trial was carried out with "grass-soil" and "sub-soil" the original pH of which was lowered with flowers of sulphur. The amounts of sulphur added were 0, 1/3, 1/2, 1, 2 and 3 ozs. per cu. ft. of soil giving 6 weeks later for grass-soil a pH of 4.5 (control), 4.2, 4.1, 4.0, 3.8 and 3.6 respectively.

It was found that the subsequent rooting of cuttings planted immediately after admixture with sulphur was about the same or less than that of the control; the two higher concentrations (2 and 3 oz.) caused scorching. When the cuttings were planted 6 weeks after the addition of sulphur, rooting was slightly promoted in sub-soil + 1 oz. sulphur (pH 4.3—4.6) and in grass-soil + 1/3 oz. sulphur per cu. ft. (pH 4.2—4.3). Higher rates of sulphur adversely affected rooting and scorched the leaves. Apparently the interval

of 6 weeks, during which time the soil was occasionally well watered, was not quite sufficient for the sulphur to become inactivated. It is likely, therefore, that the favourable influence of a lower pH was partly counteracted by the presence of free sulphuric acid.

Both trials indicated that the optimal pH for rooting is below 5.0, probably in the neighbourhood of 4.5. If sulphur is used for pH adjustment, quantities between $\frac{1}{2}$–1 oz. per cu. ft. soil will be normally sufficient, depending on the buffering capacity of the soil and its original pH. The soil must be well watered for a period of not less than 8 weeks before the cuttings are planted.

Soil media for rooted cuttings.—I. In the first experiment rooted cuttings were grown in different soils both in the beds and in baskets: grass soil, sub-soil, sub-soil/peat (and sand) mixtures and sub-soil with tea fluff. The results showed that grass soil (from "Guatemala" fields) is as good a medium for rooting as it is for subsequent growth for plants both in beds and in baskets. The next best soils for plants *in beds* were 2 parts sub-soil + 1 part peat (by volume) and sub-soil + peat + sand in equal proportions, while the sub-soil/tea fluff mixture (4 : 1) also gave promising results. The *basket* plants appeared to grow better in sub-soil containing somewhat more peat (1 : 1), presumably because they dry out quicker than plants left in beds.

II. In the second experiment the growth of plants in baskets filled with grass soil or a mixture of sub-soil, sand and peat (1 : 1 : 1) was compared with that of plants in two different tea soils (from tea fields) without or with peat (2 : 1). The plants in the former media grew almost equally well and had more than doubled their size within 4 months. The plants in the tea soils, with or without peat, showed hardly any growth at all in that period. These results confirm previous experiments on the unsuitability of tea soil for propagation. It is probable that tea soil contains a "toxic factor" inherent to decaying tea roots. Its use for either propagation or young plants (in baskets) is therefore not to be recommended.

III. In the third trial (carried out at Passara sub-station) the suitability of *coir dust* either on its own or mixed with sub-soil, peat and/or sand was tested out in comparison with mixtures of the latter soils. It appeared that pure coir-dust was completely unsuitable for propagation. In this medium only 19% of the cuttings rooted and 8% formed axillary shoots as compared with 100% rooting and 75–85% shoot formation in sub-soil and peat (equal proportions) or in a sub-soil, peat and sand mixture (1/3rd each by volume). The two latter media were also greatly superior to similar mixtures in which peat was replaced by coir dust.

The above experiments proved that soils which were found to be suitable as a rooting medium (Ann. Rep. 1957, p. 39) are also suitable for subsequent growth following root initiation. Mixtures of *sub-soil and peat, with or without sand*, compared in nearly all trials favourably with the top-soil of long-standing Guatemala grass fields and can be recommended both as propagation media and as basket soils. Instead of peat, tea fluff may be a possible alternative, though more data are required. In any case, it will be necessary to prepare (and water) the soil mixture at least 6 weeks in advance in order to allow for the decomposition of the tea fluff.

3. Shade experiment.—This experiment was initiated in order to investigate the effect of shade on the growth of tea in relation to elevation. It has been laid out at 4 locations: Neuchatel sub-station (sea level), Passara sub-station (3,300 ft.), St. Coombs (4,500 ft.) and Pedro estate (6,000 ft.).

At these 4 locations rooted cuttings were planted between November and December in beds shaded by ¼″ coir mesh (about 20% light). After the plants have become sufficiently established and have formed axillary shoots of 6–12″ length, it is intended to replace the coir by Saran gauze of different mesh width providing 40%, 55% and 75% daylight respectively; unshaded beds (100% daylight) will serve as controls. The "Saran sheds" measure 14 × 16 ft. and are 5 ft. high. Each treatment comprises two clones (2024 and 2025) and is replicated twice. It is expected that the coir can be replaced by the proposed shade treatments by about June, 1959. Thereafter, regular assessments will be carried out on root weight, axillary shoot weight, number of leaves and leaf area respectively.

4. Pre-pruning and side-pruning.—I. Two more experiments on "pre-pruning" were carried out at Gonakelle and Endane estate respectively. These trials confirmed the results obtained in the previous year (Ann. Rep. 1957, p. 43), *viz.* that pre-pruning under certain conditions (elevation and climate) may be preferable to rim-lung pruning, because it may decrease die-back. In terms of yield, pre- or rim-lung pruned bushes showed no marked differences.

II. In the "side-pruning" experiments done at St. Coombs, it was determined how the pruning of the sides of the bushes carried out some time during the pruning cycle would affect subsequent yield. It must be noted that side-pruning is in essence the same operation as pre-pruning with the difference that pre-pruning is done at the *end* of the pruning cycle, while side-pruning may be carried out at any time, *e.g.* in order to facilitate operations in a too densely-planted field at some intermediate period of the pruning cycle.

In this instance side-pruning was carried out in three fields of different density and ages after pruning, in such a way that between 45 and 60% of the original plucking table of the bush was left. This portion, depending on the area left, appeared to yield between 70 and 90% of that of unpruned bushes (for the first 16 plucks following pruning). After the sides came into bearing again, the (total) yield of the side-pruned bushes varied between 107 and 118% of that of the controls (over the 2nd 16 plucks), thus indicating that side-pruning, if required, is feasible and can be carried out without loss of crop.

5. Plucking experiments.—I. **The "old" fish leaf plucking experiment** (see Ann. Rep. 1955) completed its 6th cycle in November, 1958. It appeared that continuous normal plucking, continuous fish leaf plucking, and normal plucking preceded by fish leaf plucking in the previous cycle, did not differ significantly as regards yield. The fish leaf plucked plots, preceded by normal plucking in the previous cycle, yielded 28% more than the control (continuous normal plucking). However, the fish leaf plucked bushes showed a marked deterioration with respect to frame and maintenance foliage and yielded only one quarter of the prunings obtained from normally plucked bushes.

II. **The "new" fish leaf plucking experiment** started its first cycle in August, 1955, and consisted of the following treatments, both manured at a normal ratio (8 lb. N/100 lb. tea) and at a high ratio (12 lb. N/100 lb. tea):—

(*a*) Normal plucking throughout.

(*b*) 1st year normal plucking—fish leaf plucking—5 months resting before pruning,

(*c*) 1st year normal plucking—fish leaf plucking—5 months normal plucking before pruning.
(*d*) 1st and 2nd year normal plucking—fish leaf plucking until pruning.

The treatments have so far shown very marked differences; the fish leaf plucked plots yielded over the 2nd year 30–35% more and over the 3rd year after pruning 50–70% more than normally plucked plots. This considerable increase in yield is undoubtedly partly due to the fact that the bushes were allowed to form a reasonable frame and sufficient maintenance foliage before fish leaf plucking was resorted to. It is too early to say whether a plucking procedure as adopted in our experiment would be possible without deterioration of the bushes in the long run.

III. **The "plucking level" experiment** started its first cycle in October, 1957, and consisted of the following treatments: (*a*) Normal plucking with breaking back, (*b*) Normal plucking without breaking back (dome plucking) and, (*c*) Normal plucking combined with plucking below the plucking level along the periphery. The latter treatment was incorporated with a view to restricting the size of bush without affecting its yield and is applicable when the bushes are too closely planted. The experiment is not yet one year in plucking, but so far normal and dome-plucked plots (*a* & *b*) produced the same yield, while bushes plucked along the periphery (*c*) produced 20% more yield than the former. The latter type of plucking required about 15-20% more in labour per acre than for normal plucking.

6. Bringing into bearing experiments.—I. This experiment laid out on a field scale at Endane in December, 1956 (Ann. Rep. 1957, p. 49) will come into bearing during the middle of 1959. Preliminary assessments on leaf growth indicate that there is little to choose between layering, bending over and thumbnailing; the centered bushes appear to be somewhat behind.

II. A similar replicated experiment on two clones has been initiated at St. Coombs in July. No results are available as yet.

7. Other field experiments.—Observations continue on the *cultivation* cum *plucking* experiment at Downside Estate which started in November, 1956 (Ann. Rep. 1956, p. 42) and on the *pruning cycle* cum *plucking* experiments at Endane Estate which was initiated in February, 1957 (Ann. Rep. 1957, p. 45).

The five manurial experiments—three at St. Coombs, one at Gonakelle Estate and one at Endane Estate (Ann. Rep. 1957, p. 44)—which were previously under the ægis of the Physiology Division were transferred to the Agricultural Chemistry Division in October, 1958.

8. Sub-Stations.—**Passara.**—Twenty-two visits were made by the O.I.C. of the Station in connection with nurseries or the collection of clonal material. Six visits were made to St. Coombs and 18 to Downside Estate, Welimada.

Visitors.—The Station was visited by 34 planters mainly from the Uva District. Messrs. F. Keun of Ury Group and C. R. Burnet of Gonakelle Group were appointed unofficial visitors to the Station.

Rainfall.—A rainfall of 94.59 inches was recorded during the year.

Multiplication Plot.—Eighty-seven clones have so far been established in the test plots. Most of the clones planted in 1957 will be brought into plucking before the end of 1959. The T.R.I. clones so far appear to show

better growth than most other clones. Clones 2023, 2025 and 2026 are outstanding.

Guatemala Grass Experiment.—A replicated trial was laid out with two spacings, *viz.* cuttings planted at 2′ x 2½″ and 1½′ x 1½″, and at two rates of manuring (4 and 8 cwt. of the Guatemala mixture) respectively.

Neuchatel.—Fourteen Planters visited the Station. Mr. H. Creighton was appointed unofficial visitor to the Station.

Rainfall.—A rainfall of 113.60 inches was recorded; the number of rainy days was 190.

Multiplication Plot.—Sixty-six of the 69 clones planted in 1956 were brought into plucking in May, 1958. Individual records of clones in this block will serve little purpose as about 35 clones were badly mixed. However, selections have been made from the promising clones and cuttings will be taken only from a single bush in each clone so as to avoid the possibility of any further mix up.

The total number of clones under test in the plots is 120, of which 102 are from estates outside St. Coombs and 18 from St. Coombs. The best growers appear to be 2023 and 2026.

Shade Experiment.—A shade experiment with two clones was laid out as follows:—

(1) No shade.
(2) Plants shaded with fern at time of planting.
(3) *Crotalaria* sp.—alternate rows lopped and thatched.
(4) ,, ,, —both rows lopped and thatched.
(5) ,, ,, —alternate rows unlopped.
(6) *Stylosanthes gracilis* alternate rows: controlled round plants.
(7) ,, ,, both rows.
(8) *Crotalaria* sp. and *Stylosanthes* in alternate rows: *Stylosanthes* controlled round plants.

Compost *vs.* No Compost Trial—Treatments.: (*a*) At the time of planting 5 lb. compost was mixed with soil used for filling holes. (*b*) No compost.

Guatemala Grass Experiment.—A spacing and manuring experiment similar to the one in Passara, but with an additional treatment of 2 cuttings *vs.* single cutting per hole, was laid down.

Enselwatte.—Multiplication Plots.—There are 20 clones being grown exclusively for taking cuttings.

New Clearings.—Seven acres were planted in October/November, 1957, and 4 acres in October, 1958. The total number of clones in the clearings is 40. Clone 2024 is considered to be the most vigorous followed by 2023, 2026 and 2025. Among the clones from other estates, Kenilworth 16/3, and Craighead 13 appeared to be very promising. Sirikandura 106, Talankande 48, Ouvakellie OK4 and T.R.I. 216 are apparently slow growers.

9. Publications.—The following papers were published:—

Visser, T.—The validity of assessing tea yields on a basis of intermittent plucking and test plucking. *Tea Quarterly*, Vol. XXIX, Part I, 1958, pp. 21–29.

Visser, T. and Tillekeratne, L. M. de Waas.—Observations on the germination and storage of tea pollen and seed. *Tea Quarterly*, Vol. XXIX, Part I, 1958, pp. 30–35.

Visser, T. and Tillekeratne, L. M. de Waas.—Factors affecting the planting distance of tea. *Tea Quarterly*, Vol. XXIX, Part I, 1958, pp. 36–44.

Visser, T. and Kehl, F. H.—Selection and vegetative propagation of tea. *Tea Quarterly*, Vol. XXIX, Part II, 1958, pp. 76–86.

Visser, T.—The position of clonal selection in Ceylon in relation to replanting. *Tea Quarterly*, Vol. XXIX, Parts III/IV, 1958, pp. 154–159.

Kehl, F. H.—Experiences overseas on replanting with high-yielding material. *Tea Quarterly*, Vol. XXIX, Parts III/IV, 1958, pp. 160–163.

Visser, T.—Some aspects of the propagation of tea cuttings (Paper read at the International Horticultural Conference held in France—1958.)

10. Acknowledgments.—The co-operation of Superintendents of estates who have offered clonal material for trials on St. Coombs, Gonakelle, Neuchatel and Enselwatte is gratefully acknowledged. We also thank the Managers and Assistants of Downside, Endane, Enselwatte, Gonakelle, Neuchatel, Welimada and Pedro estates for the assistance they have given us during the year.

T. VISSER,
Plant Physiologist.

REPORT OF THE PLANT PATHOLOGIST

General.—The Acting Pathologist was relieved of his temporary duties when the present Pathologist took over in July. Dr. Visser continued to act as Nematologist during the period.

Advisory Work.—526 letters were received and 508 letters despatched during the year. 274 consignments of diseased specimens were received for disease identification and report. 26 advisory visits were made by the staff of the Division.

In order to ensure the efficiency of our advisory work, it would be appreciated if Superintendents would submit as many details as possible about diseased specimens sent in for diagnosis as this would obviate unnecessary correspondence and facilitate the work.

Research.—I. **Fungus diseases**·—1. BLISTER BLIGHT (*Exobasidium vexans*). Due to the new policy laid down by the Board regarding the testing of fungicides, no new fungicides of traditional formulations were tested out.

(*a*) **Dusting.**—A 2% copper coated dust applied at 5 lb. per acre did not compare favourably with 6 oz. wet spray.

(*b*) **Sticking agents.**—Experiments were carried out to determine whether the copper fungicides now in use for the control of blister blight could be used at a reduced level by the incorporation of stickers. Three stickers (Shell Tenac, AAstickol and Jebohecht) were tried out with 3 ozs. of pure copper oxychloride. There appeared to be no significant difference in protection between 3 oz. of pure copper oxychloride and 3 oz. of copper oxychloride + sticker. The monsoon was mild and the general level of infestation so low, that even 3 oz. of copper oxychloride gave fairly adequate protection. The addition of stickers under these conditions does not appear to have any effect.

(*c*) *Phytotoxicity.*—Experiments were conducted to determine whether or not the routine application of copper preparations at the recommended rates against blister blight adversely affects the yield of tea. Seven different fungicides were tested in a six-fold replicated field trial. None of these formulations adversely affected the yield of tea when applied at the normal rates.

(*d*) *Timing of spraying.*—Investigations were carried out during the year to devise a suitable system of timing blister blight spraying based on weather records. Two series of experiments were carried out, one based on sunshine figures and the other on the amount of spore germination obtained in the field.

The results of these experiments revealed that spore germination and subsequent penetration of the leaf probably takes between 24 and 48 hours. The development of a germinating spore into a translucent spot required about 10 to 13 days and for blister formation a period of 16 to 17 days is necessary. The experiment also showed that the degree of spore germination

and subsequent blister blight incidence are interrelated and dependent on weather conditions prevalent at the time the spores are released. The observations strongly indicated that sunshine is of more importance than rainfall in determining the degree of infection. It appeared that a change in the amount of sunshine between 2½ to 5 hours daily, caused the greatest fluctuation in germination and infestation. Spraying can also be based on the amount of spore germination obtained on the field. Spraying following on a day when the spore germination exceeded 25%, but at intervals of not less than 10 days, was as efficient as routine spraying. When spraying was based on 50% germination protection was less, but was still reasonable. In the former case there was only a saving of one spraying round while in the latter 7 rounds were saved.

A spray-timing system, based on an average daily sunshine of 3¾ hours, recorded over a 5-day period and spraying at intervals of not less than 10 days, provided effective protection, while reducing the number of spraying rounds by more than 40% over a period of 7½ months. Spraying on the basis of 3¾ hours sunshine over 7-day periods would also be possible, but is likely to be less efficient.

The results indicate that the number of spraying rounds can be reduced, if each time a spraying is due, the decision whether to spray or not is based on the amount of sunshine recorded during the previous five-day period (assuming a 10-day spraying round). On two estates the number of sprayings during the N.E. monsoon was reduced from 12 to 8 resulting in increases in blister blight of only 3 and 6 per cent respectively. In both cases the attack remained far below the danger level.

TABLE 1.—*Average monthly shoot infestation of plots sprayed according to the amount of sunshine recorded over 5-day periods*

Treatments	ESTATE A						ESTATE B					
Sunshine per 5 days	Infestation in % Sep.	Oct.	Nov.	Dec.	Avg.	No. of sprayings	Infestation in % Sep.	Oct.	Nov.	Dec.	Avg.	No. of sprayings
1. Control	11.1	7.2	11.2	5.1	8.7	12	2.3	1.8	3.0	4.1	2.6	12
2. 22½ hrs.	17.2	15.6	16.3	7.2	14.1	8	2.9	2.9	1.2	6.4	3.5	9
3. 18¾ hrs.	16.8	13.4	18.2	10.2	14.7	7	4.1	3.4	4.1	9.7	5.3	8
4. 15 hrs.	23.4	17.6	26.8	21.8	22.4	4	5.1	4.1	5.2	12.0	6.5	5

(*e*) *List of approved fungicides.*—A new list of approved fungicides was prepared which contained, besides fungicides previously tested, others which were considered as being of equal value, judging from the result of a laboratory test on their physical characteristics.

2. OIL-SPOT DISEASE.—An outbreak of a new leaf spot disease on some up-country estates has caused considerable concern. The disease is characterized by the appearance of numerous dark spots on the lower surface of the young leaves of the flush, which finally coalesce and give the whole of the underside an oily appearance. After some time the spots are also visible on the upper surface. This finally leads to the severe leaf-fall of both flush and maintenance leaf, and the death of part of the bush from the top of the branches downwards. As a rule the attack starts from one side and later proceeds to the entire bush. The leaf spot reappears on the new shoots of the same bush after pruning, and invariably on the same side.

Research has so far revealed that a fungus of the Glomerella type is consistently present in the diseased leaves. Whether or not this fungus is the causal organism will have to be decided upon by inoculation experiments. Normal spraying against blister blight does not affect the control of the disease. The lowest elevation where the disease has been found so far is 4,500 ft. Reports about its occurrence will be much appreciated.

A spraying experiment has been started. An affected bush has been transported to St. Coombs for further observations.

3. Wood-rot and die-back.—The wood-rot observations on tea in bearing were continued on Endane Estate, as also the experiment on the method of bringing into bearing in connection with wood-rot development. It is concluded that both die-back and wood-rot are not true pathological problems but conditioned by the earlier method of pruning and other cultural practices, and by the degree of attack by shot-hole borer. The amount of die-back is dependent mainly on the weather conditions after pruning and the starch reserves present. This problem is being investigated by the Physiologist.

4. Leaf-spot disease on Albizzia moluccana.—Normally leaf-spot on Albizzia is limited to young plants in the nursery. On one estate, however, severe defoliation of mature trees was reported and the diagnosis of leaf-spot due to the fungus *Pleiochaeta albizzia* (Petch) Hughs was confirmed. As control measures are not economically feasible, the planting of more Albizzias in the area was advised against.

II. **Virus diseases.**—So far only one disease of tea has been definitely described as a virus disease, *viz.* phloem necrosis, and Ceylon is the only tea-growing area in which a virus disease has been reported. It would, however, be very improbable if phloem necrosis were the only virus disease in tea and research will, therefore, be directed towards the finding of more such diseases.

1. Phloem necrosis.—The research on this disease has been resumed along the following lines:—

(*a*) Search for other host plants, one of which could be used as an indicator plant.

(*b*) Experiments on ways of transmission in the field.

(*c*) Experiments on the influence of temperature (elevation) on the development of symptoms.

(*d*) Testing of clones for the presence of the virus and their possible susceptibility to the virus.

In regard to (*c*) above it is interesting to record that some cuttings from diseased bushes removed to a low-country V.P. unit showed apparently healthy growth and no necrosis in the new leaves at the end of the year.

On one estate in the Uva district with very wide differences in elevation, some diseased bushes were transplanted from 6,200 ft. to an area of 4,500 ft. elevation where no phloem necrosis has been recorded. The bushes have recovered and are producing healthy flush without any external symptom of phloem necrosis virus disease.

2. Virus-like symptoms.—An attempt has been made to obtain an inventory of the numerous abnormal leaf patterns and forms that occur in tea. The following abnormalities have been mentioned in the literature:—

(*a*) Infectious chlorosis (white streaks) (Monograph No. 2, p. 50).
(*b*) Yellow variegation (Monograph No. 2, p. 90).
(*c*) White variegation (Monograph No. 2, p. 90).
(*d*) Polyclady (Annual Report, 1936, p. 28).

Others found on different estates are:—

(1) Green and yellow speckled leaves.
(2) Red and yellow speckled leaves.
(3) Mottle leaf.
(4) Veinbanding and vein clearing.

Of these, the last is most probably due to a virus. A collection of abnormal bushes has been started at St. Coombs.

III. **Deficiency diseases.**—(*a*) Lower leaf chlorosis.—An experiment on the control of this type of chlorosis by spraying with 2% magnesium sulphate has given good results as will be seen from the following table. The treatments were given to 10 plants each of clone No. 23. The age of the plants is 3 years.

Table 2.—*The influence of the application of 2% magnesium sulphate on the occurrence of lower leaf chlorosis*

	Date of treatments	No. of weekly treatments	% Chlorotic leaves (5-2-59)
Spraying 2% magnesium sulphate without sticker	19–9–58 7–2–59	11	5.5
Spraying 2% magnesium sulphate plus sticker	do.	17	9.0
Check		0	37.4

The experiment was carried out solely for the purpose of deciding whether the common lower leaf chlorosis is due to magnesium deficiency and not to demonstrate the value of spraying magnesium sulphate. The practical application will have to be tried out subsequently.

Judging from the symptoms of the chlorosis, magnesium deficiency appears to be quite common. The symptoms vary considerably both in severity and type according to elevation, age from pruning, and nature of clone or jat. The location of the symptoms on the branches appears to be influenced by the amount of light received by the leaves. On mature, densely-planted bushes, the first leaves below the plucking table show the most marked symptoms. Lower down the leaves are dark green again, although they are older.

The range of symptoms will have to be studied carefully before it will be possible to identify each case of magnesium deficiency by visual means.

The occurrence of magnesium deficiency symptoms is most probably strongly linked with the application of nitrogen and potassium. The more fundamental research on this subject is however outside the scope of the Pathology Division.

(*b*) Little leaf (Witches broom).—The symptom of little leaf or budscale-like leaf is very common in areas with a prolonged drought period,

and after pruning on bad soils. The problem was studied by Gadd from 1926 till 1933 when it was shown that witches broom is not due to a sulphur deficiency. Gadd also showed that too high a soil pH can cause symptoms similar to those of witches broom.

A hypothesis on which to base further research can be formulated as follows: Due to exposure of the soil after pruning the bush is compelled to take in more water and nutrients from the lower levels of the soil. As the deeper layers of the soil are less leached out, they will contain more calcium and, in general, have a higher pH, causing unavailability of some nutrient element essential to the tea bush.

Publications.—The following papers by the staff of the Pathology Division were published:—

Visser, T., Shanmuganathan, N. and Sabanayagam, J. V.—Blister blight control in 1957 with respect to fungicidal formulation, application rates and yield. *Tea Quarterly*, Vol. XXIX, Part I, 1958, pp. 9–20.

Visser, T., Shanmuganathan, N. and Sabanayagam, J. V.—A note on the effect of different copper preparations on tea yield. *Tea Quarterly*, Vol. XXIX, Part I, 1958, pp. 45–46.

Mulder, D.—Rehabilitation and tea diseases. *Tea Quarterly*, Vol. XXIX, Parts III/IV, 1958, pp. 178–179.

D. MULDER,
Plant Pathologist.

REPORT OF THE ACTING NEMATOLOGIST

1. General.—Eelworm analyses were carried out on 2,938 samples, 380 being from estates. 110 letters were received and 107 letters despatched; 24 visits were made to estates mainly for experimental purposes.

As the limited staff made it impossible to undertake the analysis of routine samples and carry out urgently required research at the same time, it became necessary at the beginning of the year to curtail drastically the examination of estate samples.

2. Sampling Techniques.—With regard to eelworm determination using the Baehrmann technique, the question arose to what extent the normal 100 g soil sample gave quantitatively reliable results. The quantity of soil used gave a relatively thick layer of soil over the sieve. This and the fact that most Ceylon tea soils are heavy loams, are likely to lead to impeded movement of the eelworms from the soil through the sieve. It may therefore be expected that only a proportion of the eelworms will be collected in the 16–24 hours allowed for that purpose.

That this happens was demonstrated in an experiment in which different quantities of soil (5, 10, 20, 30, 40, 50, 75 and 100 g) were assessed using the Baehrmann technique (each test replicated 6 times).

TABLE 1.—*Average number of eelworms (and standard error) found in different quantities of soil—expressed as number per* 100 *g. soil*

Quantity of soil tested	*Pratylenchus* + *Meloidogyne*	Other Nematodes
5 g	101.1 ± 31.4 (31.4%)	547 ± 99.6 (18.2%)
10 g	61.7 ± 10.7 (17.3%)	408 ± 51.2 (12.5%)
20 g	52.5 ± 16.1 (30.7%)	499 ± 78.3 (15.7%)
30 g	31.7 ± 6.97 (22.0%)	453 ± 71.5 (15.8%)
40 g	22.8 ± 7.05 (30.9%)	340 ± 54.9 (16.1%)
50 g	23.7 ± 5.12 (21.6%)	341 ± 66.7 (19.6%)
75 g	19.8 ± 6.12 (30.9%)	280 ± 37.9 (13.5%)
100 g	12.8 ± 3.73 (29.1%)	221 ± 25.9 (11.7%)

N.B.—Within parentheses—standard error percentages.

It appeared (see table 1) that per *unit weight* approximately 8 times more "parasitic" (Prat.+Mel.) and $2\frac{1}{2}$ times more "other" eelworms were found in 5 g. samples than in 100 g. samples. The standard errors were approximately the same irrespective of sample weight but higher for parasitic eelworms than for the others, due probably to the greater number per sample in the latter case.

Since the *actual* number of eelworms found per 100 g. soil was still greater than, *e.g.* in the 5 or 10 g. samples and the results equally reliable, we continued to base our assessments on 100 g. soil samples.

We also experimented with a new apparatus for soil sampling developed and in use by the Nematology section of the Plant Protection Service at Wageningen (Netherlands). This "flotation-can" method differs in principle from the Baehrmann technique. In the former case the soil placed on a sieve is washed into the flotation-can in which the eelworms are separated from most of the soil by means of a constant upward flow of water entering at the bottom of the can. In the latter instance the eelworms are collected on the basis of their own movement from the soil through a sieve in water.

TABLE 2.—*Average (from 7 tests) number of eelworms per 100 g. soil found in the same soil with the Baehrmann technique and the flotation-can method respectively*

Eelworms	Baehrmann technique	Flotation-can method
Pratylenchus	69.1 ± 4.2 (6.1%)	359.1 ± 32.5 (9.1%)
Meloidogyne	93.3 ± 9.4 (10.1%)	515.5 ± 60.5 (11.7%)
Other nematodes	203.8 ± 12.0 (5.9%)	329.9 ± 19.9 (6.0%)
Total	366.2 ± 17.5 (4.8%)	1204.5 ± 108.0 (9.0%)

N.B.—Within parentheses—the standard error in percentages.

When comparing the two techniques (see table 2) it appeared that the flotation-can method gave quantitatively a more accurate picture of the actual population than the Baehrmann technique, the amount of parasitic eelworms found being more than 5 times as high per 100 g. soil. Qualitatively the Baehrmann technique is as reliable or even slightly more so than the flotation-can method. However, the latter method may be preferable in cases where the eelworm population is low; also because greater quantities of soil (more than 100 g.) can be used.

Owing to great variations in the soil from place to place single samples will not give a reliable indication of the eelworm population in the soil. Accordingly, the eelworm population of our experimental plots was assessed on the basis of *composite sampling* in all instances; 4–7 samples, each obtained from the mixed bulk of 5–10 samples taken at random, were assessed per area.

With regard to *sample depth*, it was found that sampling between 2″–8″ normally gave a fair representation of the eelworm population of the soil. During prolonged dry periods sampling between 6″ and 12″ will be preferable as the eelworm density in the surface layer may be low at such times.

Root analysis was done by placing 10 g. root samples on sieves which were put over a funnel filled with water with the bottom of the sieve just touching the water surface. Sieves and funnels were kept in a "plastic tent" and submitted to a fine mist spray during 7 days.

3. Influence of Organic Matter.—Experiments on the effect of the incorporation of green matter on the eelworm population of the soil were carried out in plots to which loppings of Tephrosia, Dadaps and Marigolds respectively (1 lb. per 40 lb. soil) were added. The eelworm population of these pots was compared with those without loppings, fumigated and not fumigated respectively.

The addition of loppings decreased the meadow and root-knot population more quickly and to a lower level than that in pots without loppings (not-fumigated); fumigation reduced the population to negligible levels. The number of non-parasitic eelworms in the pots with loppings was, on the average, more than 6 times as much as that in pots without loppings. It is

possible that with the great increase in non-parasitic eelworms, presumably stimulated by the presence of organic matter, the number of predators also increased, resulting in a more speedy reduction of the parasitic eelworms.

Accordingly, the incorporation of organic matter is to be recommended, not only with a view to soil improvement but also with regard to the control of eelworms.

4. Marigolds.—In order to investigate the effect of marigold cultivation on eelworms a number of experiments were carried out over the past year:—

(*a*) Two field experiments in infested areas at Mount Vernon and Eildon Hall estates respectively in which marigolds were sown as a cover crop in mature tea after pruning and in plots from which the tea had been uprooted.

(*b*) A field trial at St. Coombs in which young tea plants (in baskets) were planted out in heavily infested soil and treated as follows: fumigated and fallow, un-fumigated and fallow, and un-fumigated with marigolds as a cover crop.

(*c*) An experiment on small plots (in duplicate) with the following treatments: young tea plants sown with two varieties of marigolds (*Tagetes erecta* and *Tagetes patula*), *Tephrosia vogelii* and *Crotalaria usaramoensis* respectively.

(*d*) A pot experiment with the following treatments: fallow, sown with two varieties of marigolds (*T. erecta* and *T. patula*), and *Tephrosia vogelii.*

The trials showed that the marigold varieties tried out notably reduced the eelworm population of the soil. The cultivation of marigolds was more effective than leaving the soil fallow. *Tephrosia vogelii* was found to be susceptible to both meadow and root-knot eelworm; *Crotalaria usaramoensis* appeared resistant. The latter confirms Gadd's earlier findings.

TABLE 3.—*Averages of 7 replicated soil and root assessments on 3 marigold varieties and some cover crops and weeds respectively grown in the same soils and at the same time*

Plants	Eelworms/100 g. soil			Eelworms/10 g. roots		
	Pr	Mel	Oth	Pr	Mel	Oth
Marigolds	2	2	382	1	19	92
Cover crops and weeds	13	18	624	320	1175	3825

Pr=*Pratylenchus;* Mel=*Meloidogyne;* Oth=Other eelworms.

As shown by the above table, marigolds appear to be practically immune to eelworm infestation compared with other plants. Admittedly, the picture is somewhat biased as the average for "cover crops and weeds" includes assessments on *Tephrosia vogelii* which plant is eelworm-susceptible. Nevertheless, even among virtually resistant plants, marigolds, when grown under comparable circumstances, stand out with respect to the few eelworms of any kind found in their roots.

When intergrown with tea after pruning it was ascertained from different experiments that the meadow eelworm population of roots from tea intergrown with marigolds was several times less than that of tea without marigolds. However, it is doubtful whether marigolds can be generally used as a cover crop in mature tea even when sown after pruning because it will normally be difficult to establish a good cover.

On the other hand, the cultivation of marigolds is likely to be useful for the reconditioning of propagation nurseries, and probably as effective as fumigation. A period of 5–7 months would be required as the flower has to reach maturity for full effect. Also for the reconditioning of eelworm infested areas which are to be replanted, the cultivation of *marigolds in combination with Guatemala grass* may be a recommendable practice, also because it would provide a quicker ground cover than grass alone.

The kind of marigold to be used for such purposes should be a vigorous-growing variety of the "bushy" type of height 4–5 ft. *T. erecta*, cult. *Plena "Colorodo Sunshine"* and *T. patula nana*, cult. *nana Plena "Harmony,"* have been found to grow well in tea soil.

5. Guatemala Grass.—Since the cultivation of Guatemala grass has assumed importance in view of the Replanting Scheme, confirmation was sought as to the resistance of this grass against eelworms, particularly meadow eelworms. For this purpose areas on St. Clair and Eildon Hall estates were chosen where heavily infested tea was interplanted with Guatemala grass both in vacancies and in between the bushes. Soil and root samples were taken from areas of (*a*) tea only, (*b*) tea interplanted with grass, (*c*) Guatemala grass only (in vacancies), and (*d*) from Guatemala grass interplanted with tea (same as *b*)

It appeared on both estates that *soil samples* from formerly infested vacancies planted in grass contained negligible numbers of meadow eelworm and some root-knot eelworms, whereas those from tea, whether intergrown with grass or not, contained 5 to 10 times the number of meadow eelworms and no root-knot eelworms.

Root samples from Guatemala grass, whether grown in between infested tea or not, harboured very few meadow eelworms as compared with roots from tea (on average 19 against 900 per 10 g. roots). Roots from tea interplanted with grass contained considerably less meadow eelworms than those from tea without grass (290 against 1500). The number of root-knot eelworms found in grass and tea roots were negligible (2 and 2 per 10 g. roots).

Further confirmation as to the effect of Guatemala grass on meadow eelworm was obtained from regular sampling on two adjacent and formerly infested areas one of which was planted in Guatemala grass and the other kept fallow. The meadow eelworm population appeared to decrease in the former case more rapidly than in the latter case.

Thus the cultivation of Guatemala grass is a practice to be recommended both with respect to soil reconditioning and eelworm control. Interplanting with tea is not always advisable because of competition for nutrients and water.

6. Cover Crops, Shrubs and Shade Trees.—In connection with replanting, it is of interest to know which plants are resistant and which susceptible to meadow or root-knot eelworm. Those which are liable to be attacked by meadow eelworms (*Pratylenchus coffeae*), like *e.g. Tephrosia vogelii*, should not be planted, as such crops are likely to maintain or build up the existing population. Those susceptible to root-knot eelworms (*Meloidogyne javanica*), like *e.g.* dadaps,

though not dangerous to well-grown tea plants more than 6–8 months old, may be found difficult to establish in soil infested with this eelworm.

Accordingly, soil and root samples were taken from plants growing in areas alleged to be infested, both at St. Coombs and other estates. The soil samples were obtained from the immediate neighbourhood of the roots collected for sampling.

TABLE 4.—*Average number of eelworms in soil and root samples for different cover crops, shrubs and shade trees*

Plant Species	No. of Samples	Eelworms per 100 g soil			No. of Samples	Eelworms per 10 g roots		
		Pr	Mel	Oth		Pr	Mel	Oth
Drymaria cordata	6	3	0	406	4	6	0	112
	6	1	1	314	2	2	3	139
Mimosa invisa	6	0	1	951	4	0	17	263
	6	0	2	588	2	1	270	1134
Stylosanthes gracilis	3	0	0	146	2	0	0	102
	2	1	5	422	2	1	1	70
Crotalaria usaramoensis	1	0	0	243	2	1	0	318
	6	4	0	240	4	3	0	469
Crotalaria anagyroides	6	3	9	466	4	1	0	52
	3	10	0	330	3	4	0	59
Sesbania cinerescens	6	5	5	1125	5	49	16	64
	6	0	45	740	2	1	146	134
Tephrosia vogelii	6	10	60	1350	2	1630	5620	14630
	3	0	141	460	2	0	43	83
	6	45	4	723	4	480	38	570
Acacia decurrens	3	2	19	286	2	1	12	15
	6	6	0	456	3	50	1	75
Calpurina aurea	6	57	6	651	4	46	0	140
	6	18	0	589	2	17	3	62
Erithryna lithosperma	2	53	0	379	2	9	132	40
	12	3	55	342	2	3	178	93
	6	1	10	622	5	7	255	197
Gliricidia maculara	3	2	19	286	2	1	12	15
	6	6	0	456	3	50	1	75
Albizzia moluccana	6	6	0	521	5	5	0	29
	6	2	0	536	2	41	0	108
Albizzia sumatrana	3	0	6	226	2	0	0	112
	6	0	25	247	4	2	501	109
	3	2	30	557	2	0	1630	140
Grevillea robusta	3	36	0	876	2	0	0	28
	3	0	5	659	2	0	0	117
Young tea	10	133	0	303	8	4822	1	1432
Mature tea	8	30	12	333	4	430	2	416

Pr=*Pratylenchus;* Mel=*Meloidogyne;* Oth=other eelworms.

The tabulated results of soil and root sampling show that *e.g. Albizzia sumatrana, Erythrina lithosperma* (dadap), *Sesbania cinerescens* and *Mimosa invisa* appear to be to a greater or lesser extent susceptible to root-knot eelworms; *Tephrosia vogelii* is susceptible to both meadow and root-knot eelworm. The other plants are only lightly infested by meadow or root-knot eelworms and therefore would appear to be more or less resistant.

Possibly in a few cases where the plants were found to be lightly or not at all attacked, this may be due not so much to resistance but to the fact that the eelworm population of the soil was small.

However, in most instances it is fairly certain that the majority of the plants tested are not congenial hosts for *Pratylenchus coffeae.* This is also clear when one compares the infestation of tea by this eelworm with that of the other plants. As the listed plants were tested when mature, it is also possible that some of them, in a young stage, may be found susceptible to meadow and/or root-knot eelworm.

7. Fumigation.—I. Previous findings indicated that Nemagon when applied at rates exceeding 20 gallons/acre, caused only mild toxic symptoms (scorch) on tea. At the recommended rate of 10 gallons + 20 gallons kerosene per acre (on 4 sides of the bush with 10 ml. injected) it proved to be completely harmless, having no adverse effect on yield (see table 5).

TABLE 5.—*Fresh weight yields per acre before and after fumigation (F) with Nemagon (6 plots of 1/12th acre/treatment)*

Treatments	18 plucks before F	12 plucks after F
Control ...	2,056 lb.	1,166 lb.
Fumigated ...	2,043 lb.	1,164 lb.

N.B.—For uniformity of yield, plots of a former field experiment were chosen for this trial.

In the above case where the yields of non-fumigated and fumigated plots were the same, we had chosen on purpose an area which was not infested in order to be able to assess the direct effect of Nemagon on the tea bushes. However, when fumigation is carried out in eelworm infested tea an increase in yield, as observed in one of our estate trials, can be expected.

II. With regard to toxicity in the nursery an experiment was carried out in which cuttings were planted in eelworm-free soil 1, 3, 5 and 7 weeks respectively after fumigation with Shell DD at 400 lb. and Nemagon at 5 gallons (+ 35 gallons kerosene) per acre respectively; the control was not fumigated.

When planted 1 week after fumigation 95, 97 and 65% of the cuttings had rooted, and 95, 97 and 27% respectively had formed an axillary shoot 11 weeks later in beds untreated, treated with Shell DD, and Nemagon respectively. Hence contrary to expectations Nemagon appeared in this case to be slightly toxic while Shell DD was not. Cuttings planted 3 weeks after fumigation and later did not significantly differ in rooting or growth irrespective of the pre-treatment of the beds.

III. In a trial with Shell DD at 400 lb./acre in which young tea plants in baskets were planted in an (infested) area only 2 weeks after fumigation,

no harmful effects were observed. The plants were found to carry 6 months later twice as many leaves as plants put out in the adjacent un-fumigated area. The meadow eelworm population in the soil and tea roots of the fumigated plot were 10 and 17% respectively of that of the un-fumigated plot.

IV. In a small scale field trial carried out by Fisons (Ceylon) Ltd., (and sampled by us), the phytotoxicity of Nematox 100 (ethylene dibromide) on mature tea was investigated at the approximate rates of 2.7, 5.3 and 8.0 gallons/acre injected at 2, 4 and 6 ml. per point on four sides of the bush respectively, both "shallow" (3″) and "deep" (9″).

It appeared that shallow injection caused no visible harm, but was somewhat less effective in killing eelworms than soil injection at greater depth. With regard to the latter, the lowest rate (4 × 2 ml.) had no detrimental effect, but the two higher rates caused the death of 20% of the bushes within 1 month after fumigation. About 7 months after treatment the meadow eelworm population varied between 5 and 20% of the control, but the root-knot eelworm population was higher than in the untreated plots. A similar phenomenon was observed in other trials with Nemagon.

It would seem, therefore, that fumigation may be less effective against root-knot eelworm than against meadow eelworm.

Summarising the findings it can be said that soil fumigation with Nemagon is not phytotoxic to mature tea, but may delay rooting of cuttings if sufficient time is not allowed to elapse between fumigation and planting. When no plants are present, Shell DD and Nematox 100 can also be used.

Under favourable circumstances a kill of at least 90 to 95% can be obtained with soil fumigation. However, it must be expected that the soil, depending on its initial population, will be slightly to moderately re-infested after about 7 months when carrying tea throughout (many if not most eelworms *living in the roots* will probably survive fumigation with Nemagon).

With regard to the fumigation of propagation nurseries (for cuttings), it is recommended to plant out not earlier than 5 weeks after fumigation. With regard to basket soil a period of at least 10 weeks seems advisable in order to starve out surviving eelworms. "Tea soil" should be avoided both for nurseries and for baskets.

8. Selection on Eelworm Resistance.—A start was made with the assessment of 69 clones planted in eelworm infested pots and 78 clones planted in an infested area in regard to their susceptibility or resistance to infestation by meadow eelworm.

It appears from eelworm analysis of the soil and visual observation on the growth of the bushes, that clones can be classed in 3 different categories:

(*a*) Susceptible and not tolerant (bush degenerates).
(*b*) Susceptible and tolerant (bush healthy so far).
(*c*) Resistant (bush healthy).

As the observations are not completed as yet, the publication of the results will have to be deferred to a later date. It is hoped that it will be possible to select a few resistant and good yielding clones in the near future.

9. Publications.—The following papers were submitted for publication:—

(1) A note on the effect of marigolds and some other crops on the *Pratylenchus* and *Meloidogyne* populations in tea soil (T. Visser and M. K. Vythilingam).
(2) Observations on the prevalence and control of parasitic eelworms in tea (T. Visser).

T. VISSER,
Acting Nematologist.

REPORT OF THE ENTOMOLOGIST

Advisory.—828 letters were received and 701 despatched. 162 consignments of specimens were received for examination and report and of these 45 related to tea mites. The more important outbreaks of insect pests and mites on tea, and crops associated with tea, are tabulated below.

Of a total of 73 visits to estates made by the staff, 48 were in connection with experimental work and 23 of an advisory nature.

The Entomologist addressed three district Planters' Association meetings while the Senior Assistant, Mr. D. J. W. Ranaweera, conducted a demonstration cum talk on tea mites at a meeting of the Bogawantalawa sub-district Planters' Association.

One meeting of the Mite Consultative Committee was held at St. Coombs during the year.

TABLE 1.—*Reported outbreaks of some insect pests and mites of tea during* 1958

Name	Total
Aphids: (*Toxoptera aurantii* Boyer)	4
Army Worm: (*Prodenia litura* F.)	3
Bag Worm: (*Psyche* sp; *Clania* sp.)	12
Bark-eating Borer (*Indarbela quadrinotata* Wlk.)	3
Brown Bug (*Saissetia coffeae* Walk)	5
Green Bug (*Coccus viridis* Green)	2
Lobster caterpillar (*Stauropus alternus* Walk)	1
Lygus Bug (*Lygus viridanus* Motsch)	4
Mosquito Blight (*Helopeltis theivora* Waterh)	4
MITES:	
Purple mite (*Calacarus carinatus* Green)	6
Red Spider mite (*Oligonychus coffeae* Nietn)	10
Scarlet mite (*Brevipalpus australis* Tucker)	13
Yellow mite (*Hemitarsonemus latus* (Banks) Ewing)	16
NETTLE GRUBS:	
Blue-stripped Nettle Grub (*Parasa lepida* Cram)	3
Fringed Nettle Grub (*Natada nararia* Mo)	5
Morawak Korale Nettle Grub (*Thosea recta* Hmpsn.)	3
Red Borer (*Zeuzera coffeae* Nietn)	10
Shot-hole Borer (*Xyleborus fornicatus* Eich)	16
Tea leaf miner (*Agromyza theae* Bigot)	4
Tea leaf skeletonizer (*Piesmopoda rufimarginella* Hmp.)	1
Tea leaf roller (*Gracilaria theivora* Wlsm.)	3
Tea Tortrix (*Homona coffearia* Nietn.)	23
TERMITES:	
Low-country tea termite (*Glyptotermes dilatatus* Bergn.)	2
Scavenging termites (*Termes* sp.)	1
Termites in factory (*Termes* sp.)	1
Up-country tea termite (*Calotermes militaris* Desn.)	2
White Grubs (*Anomala* sp., *Microtrichia* sp.)	11

TABLE 2.—*Reported outbreaks of some insect pests of green manures, shade trees, etc. during the year* 1958

Name	Host	Total
LEAF-EATING CATERPILLARS:		
Acherontia lachesis F.	Dadap	2
Cirphis unipuncta Haw.	Guatemala grass	4
Dasychira horsfieldi Saund	Dadap	1
Macaria pluviata F.	Albizzia	1
Taragama dorsalis Wlk.	Acacia; Dadap	2
Terias silhetana Wallace	Albizzia	4
STEM-BORING CATERPILLARS:		
Terastia meticulosalis Guen.	Dadap	2
BEETLE BORERS:		
Platypus solidus Walk. ...	Grevillea	2
Xyleborus excisus Walk.	Grevillea	3
Xyleborus fornicatus Eich.	Albizzia	2
SCALE INSECTS:		
Icerya purchasi Mask.	Acacia; Albizzia	2

Mites.—Next to shot-hole borer, mites continued to be the important entomological problem calling for further investigation. The report of the Special Entomologist, Dr. E. Judenko, deals with the work carried out on the economic control of the pest.

Of the four mites known to attack tea, *i.e.* scarlet mite (*Brevipalpus australis* Tucker), yellow mite (*Hemitarsonemus latus* Banks), red spider mite (*Oligonychus coffeae* Nietn) and purple mite (*Calacarus carinatus* Green), the first two species are the more serious in that they cause considerable damage leading to loss of crop. While scarlet mites live and breed on the underside of mature foliage, and very often cause defoliation in fields three years and over from pruning, yellow mites confine their attention to the flush. It is the tipping fields, and those that are in their second year from pruning, that are most susceptible to attacks by yellow mite.

Apart from the application of sulphur and the discarding of three rounds of plucking to avoid taints in the made tea, no acaricide has yet been found toxic to yellow mite. Against the three other mites, two non-tainting acaricides, Akar (*Chlorobenzilate*) and Karathane, are known to be effective.

But one problem, where scarlet mite is concerned, is to evolve a technique of applying acaricidal sprays to the underside of mature foliage when the tea is in its third year from pruning. It is at this period that scarlet mites reach their greatest number and owing to the heavy foliage on the bushes, it is extremely difficult to ensure that the spray reaches every leaf on the bush. The alternative is to dust the bushes. A few estates are therefore carrying out field trials with power dusters to ascertain whether dusting is more efficacious and economical than spraying.

Experiments to study the movements of scarlet mites especially whether they climb trees like Grevilleas and Albizzias from surrounding tea were carried out on young shade trees growing in the grounds close to the laboratory at St. Coombs. Having first made sure that both the Grevilleas and Albizzias were free of all mites, half the number of trees were banded with the tanglefoot known as "Ostico." It was assumed that the mites might climb, and the purpose of banding the trees with the tanglefoot was to ascertain

whether it would prevent a migration upwards and how long such a single application would remain effective. Tea leaves heavily infested with scarlet mites were left at the base of each young tree to induce artificial infestation.

Results indicated that a very small number of mites climb up the stems of both Grevilleas and Albizzias and establish themselves on the foliage and that one application of "Ostico" is effective over a period of at least three months in preventing a migration up the trunks of the trees.

Acaricidal trials.—Reference was made in the annual report for 1957 (Bull. No. 39, pp. 54 & 55) to a field trial at St. Coombs to determine the relative effectiveness against scarlet mite of (*a*) the heavy application of sulphur (Spersul) as a post-pruning prophylactic spray and (*b*) the application of a non-tainting acaricide (Akar) as a superficial spray incorporated in the normal blister blight control copper spray, commencing 3 weeks after pruning.

The results indicated that up to 6 months from pruning the heavy spray treatment with sulphur was more effective in reducing the mite population than the Akar and copper light spray treatment. Thereafter, there was a build-up of mites in both treatments so that at the 15th month from pruning the mite population was about the same in the two. Up to 20 months there was no difference in yield between the plots in the two treatments.

A replicated trial to determine the relative value of resting *versus* plucking after applications of sulphur for the control of scarlet mites, was started in March in a field 21 months from pruning at St. Coombs. For the effective control of mites, three to four weekly applications are necessary. In order to avoid taints in the manufactured product, leaf from treated areas should either be discarded during the period of treatment and three weeks after the last application, or the treated area should be put out of plucking during the whole of the above mentioned period which amounts to about six weeks if plucking rounds are at weekly intervals.

Monthly mite counts and dry weight yields of weekly pluckings from March 1958 to December 1958 are given below:—

TABLE 3.—*Monthly mite counts and dry weight yields*

Treatment	Total mite counts from March, 1958, to December, 1958	Dry wt. yield (lb.) from March, 1958, to December, 1958
Sulphur sprayed for 3 weeks and rested during the spraying period and for a further period of 3 weeks	1,352	231.9
Sulphur sprayed for 3 weeks and weekly pluckings discarded during the spraying period and a further period of 3 weeks ...	1,293	244.3
Control (unsprayed) weekly pluckings taken for manufacture throughout ...	11,197	280.7

It will be seen that mite population in the sulphur-treated plots has been considerably reduced as a result of the treatments. The amount of harvested crop has however been higher in the untreated plots than in the treated plots. Very little difference is shown between the crop records of the two treatments. The experiment continues.

Two series of small scale field trials to test the efficacy of acaricidal dusts and sprays for the control of scarlet mites, were conducted on St. Coombs on tea 3 years from pruning. Mite counts were recorded immediately before the weekly applications of acaricides and one week after the last application.

TABLE 4.—*Results of trial No.* 1

Treatment	Living Mites		
	Before application	After 3rd application	Population as percentage of that before treatment
Karathane 4% dust at the rate of 30 lb. per acre	640	323	50.5
Karathane wettable powder 1 lb. in 100 gals. of water at the rate of 150 gals. per acre ...	985	50	5.1
Aramite W.P. 1 lb. in 50 gals. water at the rate of 150 gals. per acre	629	60	9.5
Malathion 50% E.C. 1 part in 400 parts of water at the rate of 150 gals. to the acre ...	600	398	66.2
Spersul 1 lb. in 25 gals. of water at the rate of 150 gals. to the acre	825	16	1.9
Control (untreated)	736	996	135.3

It would appear from the results summarized in table above (No. 4) that while spray applications of Karathane W.P., Aramite W.P., and Spersul, are all effective, applications of Karathane as a 4% dust and Malathion as a spray, are not so satisfactory against scarlet mites.

TABLE 5.—*Results of trial No.* 2

Treatment	Living Mites		
	Before application	After 4th application	Population as percentage of that before application
Karathane 4% dust at the rate of 50 lb. per acre	1716	246	14
Karathane 4% dust at the rate of 30 lb. per acre	1293	326	25
Aramite W.P. 1 lb. in 50 gals. of water at the rate of 150 gals. per acre	1552	97	6
Control (untreated)	903	766	85

Table 5 indicates that at least 4 weekly rounds of 4% Karathane dust, at the rate of 30—50 lb. per acre, are necessary for the achievement of a fair degree of control of scarlet mites.

Acaricidal trials at Gouravilla Estate.—In the annual report for 1957 (Bull. No. 39, p.55) reference was made to the trials which are being conducted on Gouravilla estate with the active co-operation of the Superintendent, Mr. P. R. U. Easteal. The first application of Akar and the second application of sulphur were given during the year. A total of 49 pluckings and 7 monthly estimates of mites were recorded to the end of 1958.

Mite populations appear to be low both in treated and untreated plots. No significant difference in yield is evident so far in either treatment. The experiment continues till the end of the cycle.

Distribution of the ambrosia fungus by shot-hole borer (*Xyleborus fornicatus* Eich).—There has always been some uncertainty as to how the female shot-hole borer carries the ambrosia fungus *Monacrosporium ambrosium* from one gallery to another. While some investigators assert that one method consists in the conidia or reproductive bodies of the fungus being either voided in the excreta or carried in the crop of the female beetle and regurgitated when a fungus bed is prepared, others maintain that the conidia adhere to groups or tufts of hairs on the head of the beetle and get rubbed off once the insect is established in her burrow or gallery.

This problem was investigated by Mr. E. F. W. Fernando, the Technical Assistant, a summary of whose findings is as follows:—

"The female *X. fornicatus* carries the spores of the ambrosia fungus in two sacs one on either side of the head anterior to the brain and each opening by a duct into the dorsal part of the oral cavity. These spores were not found stored in any other part of the body of the female. After a new gallery has been constructed the female transmits these spores through the duct and then through the mouth into the gallery to start a fresh culture of the ambrosia fungus for the new generation of larvae. The male beetle has no such structures, externally or internally either for the storage or transmission of the fungus."

Beetle borers in shade trees.—Towards the middle of the year a couple of estates in Uva reported that young Grevilleas (*Grevillea robusta*) and Albizzias (*Albizzia falcata*) were dying as a result of attack by beetle borers. Specimens of the beetles sent to the Commonwealth Institute of Entomology were identified as *Xyleborus fornicatus* Eich. on *Albizzia falcata*; *Xyleborus excisus* Walk. and *Platypus solidus* Walk. on *Grevillea robusta.*

Notes made on the estates concerned confirmed observations made previously, also in Uva, that shot-hole borer beetles attack trees like Grevilleas when they are diseased or subject to some physiological disturbance. A healthy Grevillea is never able to accommodate a living *Xyleborus fornicatus* beetle for the simple reason that the boring beetle is quickly trapped in the gum which exudes when the bark is injured. Further corroboration of these observations is found in a remark in the communication from the Commonwealth Institute of Entomology when sending the above identifications. Referring to Grevilleas a paragraph reads: "It would seem unlikely that really healthy trees (Grevilleas) would be attacked and *Platypus solidus* usually confines its attacks to damaged or felled trees."

Tea Tortrix (*Homona coffearia* Nietn.)—A disturbing feature during the year was the large number of outbreaks of this once-upon-a-time serious pest of tea. The total of 23 outbreaks was the highest on record since the long-tailed parasite *Macrocentrus homonae* Nixon was imported from Java in 1935/36

and subsequently controlled the pest most efficiently. The large number of outbreaks is attributed to the local inability of the imported parasite to keep its local host under control. The reasons for this are to be investigated.

White Grubs.—"White grub" is a common name popularly given to the larval stages of cockchafer beetles. While the adult beetles are leaf feeders, the larvae live in the soil and feed on decaying vegetable matter and young tender roots of various plants. Hitherto both beetles and larvae have been considered a pest of minor importance. The beetles are at certain seasons a pest of green manure and shade trees when they feed on the foliage. The larvae were invariably confined to nurseries and nursery baskets where they had found their way through compost which had not been manufactured thoroughly. In recent years with the opening of new clearings the larvae are commencing to become a serious pest and considerable damage has been reported from the Uda Pussellawa and Uva districts.

Since very little is known regarding the bionomics of these beetles, and there are about 4 or 5 species of beetles involved, a series of laboratory and field studies was started during the latter part of the year. A replicated field trial was laid down on an estate in the Uda Pussellawa district to determine the efficacy of 5 soil insecticides mainly against the larvae in a new clearing. The insecticides tested are Aldrex 2, Aldrin 40% W.P., Intox 8, Aldrin 2½% dust, and B.H.C. dust (Gammexane D120).

Lygus Bug (*Lygus viridanus* Motsch).—The Research Assistant, Mr. D. Calnaido, to whom the study of the biology and the distribution of this plant bug was assigned, completed his investigations which will be published in due course, in the *Tea Quarterly*. The life cycle of the bug is as follows: Egg stage—2 weeks; nymphal stage—3 weeks; longevity of adults—2 months, under insectary conditions at St. Coombs.

The damage caused by the bug has already been referred to in previous reports and especially the symptoms caused by the punctures on flush which are frequently mistaken for the "Cercosporella" leaf disease of tea.

Control measures recommended so far are hard plucking and spraying or dusting with D.D.T.

An observation made during the year is that oviposition is not necessarily confined to the flush or tender foliage. Eggs have been found on the stem below the fish leaf. This is perhaps the explanation why some estates have found hard plucking not a very effective measure of control.

Owing to the presence of the bug in weeds growing between rows of tea, it is advised that spraying should not be confined to the tea alone but applied on all types of vegetation growing in or near affected tea fields.

Nettle Grub.—Judging from the number of reports received, this caterpillar pest was not common in 1958. Outbreaks, however, continue to be reported mainly from Uva.

The granulosis disease known as "Wilt" and hitherto known to attack only *Natada nararia*, the fringed Nettle Grub, was during the course of the year observed to be very effective in controlling a severe outbreak of the cosmopolitan caterpillar, *Prodenia litura*, in a field recovering from pruning. The identification was made by the Virus Research Institute at Cambridge.

A field trial with a granulosis obtained from the cabbage butterfly *Pieris brassicae*, received from Dr. Kenneth Smith of the Virus Research

Institute, Cambridge, was carried out in Uva. A one percent spray was most effective against *Natada* when it brought about a mortality between 80 and 90% within five weeks of application.

Publications.—The following articles were contributed by the members of the Mite Consultative Committee and the Entomological staff.

Mulrenan, C. N. J.—Observations on mite attacks in Haputale. *Tea Quarterly*, Vol. 28, Pts. 1 & 2, pp. 47-49.

Mulrenan, C. N. J.—Further observations on mite attacks in Haputale during 1957. *Tea Quarterly*, Vol. 29, Pt.1, pp. 60-63.

Easteal, P. R. U.— Some notes on scarlet mites and longer pruning cycles. *Tea Quarterly*, Vol. 29, Pt. 2 pp. 129-131.

Ranaweera, D. J. W.—Acaricidal trials against scarlet mite *Brevipalpus australis* Tucker, *Tea Quarterly*, Vol. 29. Pt. 2., pp. 125-128.

Calnaido, D. — Notes on the distribution and biology of the Lygus Bug, *Lygus viridanus* Motsch. (Heteroptera—Miridae), a pest of tea in Ceylon (awaiting publication).

Fernando, E. F. W.—Two new species of parasitic Hymenoptera from Ceylon (awaiting publication).

—do— Descriptions of the immature stages of the shot-hole borer (*Xyleborus fornicatus* Eich) of tea (awaiting publication)

—do— Storage and transmission of ambrosia fungus in the adult *Xyleborus fornicatus* Eich (Coleoptera Scolytidae) (awaiting publication).

D. J. W. RANAWEERA,
Officer-in-Charge.

REPORT OF THE ENTOMOLOGIST, SPECIAL RESEARCH

1. General.—The laboratory work was carried out as previously at Millawitiya Estate, near Ratnapura, but field work was conducted at other estates situated in the low- and mid-country.

Work was confined solely to small-scale field experiments on chemical methods for the prevention of shot-hole borer (*Xyleborus fornicatus* Eich.) attack on tea in plucking.

2. Spraying of the basal parts of the tea bushes.—**A.** The lay out of the experiment and precautionary measures taken are described in the article "Preliminary small-scale field experiments on a chemical method for the prevention of shot-hole borer (*Xyleborus fornicatus* Eich.) attack on tea in plucking," *Tea Quarterly*, Vol. XXIX, Part II, pp. 115–124.

The insecticides Chlordane and Dieldrin were tested. In regard to the effect of these on mortality of the beetle, the latter gave more promising results.

AGE AFTER PRUNING AT THE TIME OF SPRAYING.—The bushes were mainly 6–21 months after pruning at the time of spraying.

HEIGHT OF SPRAYING.—If the average height of tea was 3 ft. or less, the bushes were sprayed in the majority of experiments at a height of 1 ft. above ground level, while in the case of bushes more than 3 ft. high, spraying was generally done at a height of 1½ ft. above the ground level.

B. Influence of Dieldrin on shot-hole borer.—

Treatment	Average approximate data per acre (2,500 bushes in plucking)			Remarks
	Amount of active ingredient of Dieldrin lb.	Cost of Dieldrin Rs.	Amount of solution Gals.	
1	12.25	270	245	Considerable reduction in number of beetles in 3, 6, 7, 8 and 12 months after single spraying. Observations are being continued
2	5.5	120	110	Considerable reduction in number of beetles in 4, 6, 8 and 9 months after single spraying. Observations are being continued
3	2.75	60	110	Experiments are in progress
4	1.1	24	110	Experiments have been commenced in January, 1959
5	0.55	12	110	In general the experiments gave unsatisfactory results. In one of the experiments Dieldrin brought about a considerable reduction in numbers of beetles in 2 and 6 months after single spraying, whereas in the remaining two experiments the reduction of beetles was small in 2 and 7 months after single spraying

Treatment No. 1 was primarily investigated to find out the effectiveness of the contact insecticides, sprayed only on the basal parts of tea, on shot-hole borer. After it became apparent that this treatment gave satisfactory results with regard to the mortality of the beetles, it was included for comparison as a measure of "maximum kill" in all experiments except one relating to treatments Nos. 2—5. Thus, to evaluate the effectiveness of treatments Nos. 2—5 data obtained from the plots to which these treatments were applied are compared not only with data obtained from the untreated plots but also with data obtained from the plots of treatment No. 1.

Results obtained up to date with treatment No. 2, in general, did not differ from those obtained from treatment No. 1.

Rain on the day of spraying, *i.e.* during the spraying or after, did not influence the results of treatment, provided it was not higher than about 0.5."

C. Influence of Dieldrin on plant tissue of tea.—No injuries were caused to the bushes by any of treatments described above.

D. The following points with regard to spraying with Dieldrin have not yet been investigated :—

(*a*) influence on other pests of tea
(*b*) influence on parasites and predators of pests of tea
(*c*) the human health aspect
(*d*) the technological aspect
(*e*) the economic aspect

No practical recommendations emerged from the experiments described above.

3. Spraying of Insecticides on the Soil Surface of Tea Land.—

As laboratory experiments had indicated that shot-hole borer comes in contact with soil occasionally, experiments were started with the spraying of the soil surface of tea land with different chemicals.

4. Publications.—The following papers were published :—

Some observations on the behaviour of the adult shot-hole borer (*Xyleborus fornicatus* Eich.) under laboratory conditions. *Tea Quarterly*, Vol. XXIX, Part I, 1958, pp. 47–50.

Trials with a method of assessment of infestation caused by shot-hole borer (*Xyleborus fornicatus* Eich.) on old tea. *Tea Quarterly*, Vol. XXIX, Part I, 1958, pp. 51–59.

The appearance of adult shot-hole borers (*Xyleborus fornicatus* Eich.) outside their galleries under natural conditions. *Tea Quarterly*, Vol. XXIX, Part II, 1958, pp. 104–111.

A note on the distribution of the entrances to the open galleries made by shot-hole borer (*Xyleborus fornicatus* Eich.) on tea. *Tea Quarterly*, Vol. XXIX, Part II, 1958, pp. 112–114.

Preliminary small-scale field experiments on a chemical method for the prevention of shot-hole borer (*Xyleborus fornicatus* Eich.) attack on tea in plucking. *Tea Quarterly*, Vol. XXIX, Part II, 1958, pp. 115–124.

E. JUDENKO,
Entomologist, Special Research.

REPORT OF THE LOW-COUNTRY ADVISER

General.—The Low-Country Adviser was called upon to act as Director of the Tea Research Institute from the beginning of March and was functioning in that capacity at the end of the year. Accordingly, the main activities of this Division were restricted to the completion of the experimental work at Ingiriya Estate and the conduct of proceedings in connection with the purchase of an estate for the sub-station. It is pleasing to record that Mutwagalla Estate in Kiriella, Ratnapura District, with a total of 845 acres inclusive of 554 acres of tea in varying stages of development and 156 acres of rubber, was selected for the purpose. This is now being acquired for the Institute by Government under the Land Acquisition Act. An interest-free loan of Rs. 2 million was approved by Government for the purposes of the sub-station.

Action was also taken to secure from Government a 25-acre block of land for a Vegetative Propagation Unit for the Galle District. A suitable block of land was selected in the Kottawa area but owing to difficulties with encroachments the land has not yet been handed over to us. The Government Agent has, however, promised to do so as early as possible.

Pruning experiment at Ingiriya.—The pruning experiment at Ingiriya Estate was terminated in July when it had completed 6 years. As the yield figures in respect of the period July to December, 1956, were found unsatisfactory, they are eliminated from the data obtained for the whole period. The corrected yields for the remaining period are as follows:—

TABLE 1

Average Cycle (years)		Total yield lbs. per acre	Average annual yield lbs. per acre
$1\frac{1}{2}$	...	6,424	1,168
2	...	6,016	1,093
$2\frac{1}{2}$	...	5,727	1,041
3	...	6,161	1,120

The $2\frac{1}{2}$ year cycle plots were still in plucking when the experiment was terminated and the yields from these plots are not considered in evaluating the data. The results would appear to indicate that under the experimental conditions, the 18-month cycle is slightly superior to and the 3-year cycle equally satisfactory from the standpoint of yield to the 2-year cycle. It should be mentioned, however, that the incidence of shot-hole borer at Ingiriya is very low, accounting for the beneficial results obtained from the 3-year cycle. In other areas where the pest is serious this finding may not apply.

With a view to correlating yield with physiological factors, data was obtained by random sampling of the plots, on the average height and surface area of bushes, number and thickness of branches, weight of leaf below pruning cut (maintenance leaf) and of prunings, and on starch contents of roots (qualitatively) for each of the treatments.

The results obtained are furnished in table 2 below.

TABLE 2.—*Ingiriya Pruning Experiment—Assessments*

	Average per bush			Percentages		
Cycle (years)	1½	2	3	1½	2	3
Height (in.)	36	40	47	100	111	131
Surface area of bush (sq. in.) ...	1334	1463	1656	100	110	124
No. of branches at pruning level	122	112	77	100	92	63
Thickness per branch (in.) ...	0.25	0.25	0.29	100	100	116
Leaf below pruning cut (maintenance) (lb.) ...	0.15	0.11	0.10	100	73	67
Weight of prunings (lb.) ...	4.9	6.0	6.8	100	122	139
Starch (units)	1.07	0.93	1.21	100	87	113

It would be seen that in respect of the 1½, 2 and 3 year cycles, as is to be expected, height and surface area of bushes, average thickness of branches and weight of prunings increase as the pruning cycle lengthens, while number of branches and the amount of leaf below the pruning cut decrease with duration of pruning cycle. No conclusions can be drawn in regard to the starch content of roots from the different plots.

The data for the 2½ year cycle plots, which were in active plucking, are omitted for obvious reasons.

Acknowledgments.—I have to acknowledge my indebtedness to Mr. L. M. de W. Tillekeratne for having supervised the experimental work connected with the physiological study referred to above and for working out the data.

I have also to thank all members of the planting community in the low-country for the co-operation which they extended to me during the year and to express the hope that this association would be considerably closer during the coming year when the low-country sub-station renews its activities in its new home at Mutwagalla estate.

A. W. R. JOACHIM,
Director & Low-Country Adviser.

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NOTICES

General.—The laboratories of the Institute are situated at St. Coombs Estate, Talawakelle, and letters and enquiries should be addressed to the Director, Tea Research Institute, Talawakelle. Telegraphic address: RESEARCH, TALAWAKELLE, Telephone: Talawakelle 44 (Private Exchange).

It is particularly requested that letters should not be addressed to officers by name. Specimens and other consignments sent by rail should be forwarded to Talawakelle Station C/o Messrs. M. Y. Hemachandra & Co., Ltd., Forwarding Agents. *Carriage should be pre-paid.*

Low country estates should address their correspondence and enquiries to St. Coombs for the time being.

Visitors' Days.—The *second* and *last* Wednesdays in each month have been set aside for Visitors' Days at St. Coombs Estate and also at the T.R.I. Sub-Station, Gonakelle Estate, Passara, when it is hoped anyone interested will visit the stations.

Publications.—The *Tea Quarterly*, Bulletin New Series, Pamphlets and Annual Reports published by the Tea Research Institute will be sent free of charge to Superintendents of Ceylon tea estates over 10 acres in extent, and to estate Agencies dealing with Ceylon tea, if they register their names with the Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle.

Other persons can obtain the publications of the Institute on application to the Director, the subscription being Rupees fifteen per annum for persons resident in Ceylon or India, and £ 1-5-0 for those resident elsewhere. Single numbers of The *Tea Quarterly* can be obtained for Rs. 2-50 or 4*s*. In the case of Indian cheques four annas should be added to cover commission.

The Tea Research Institute of Ceylon

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